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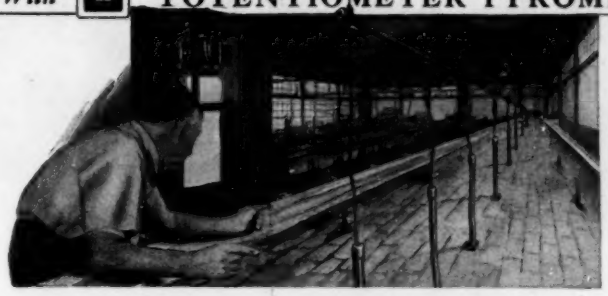

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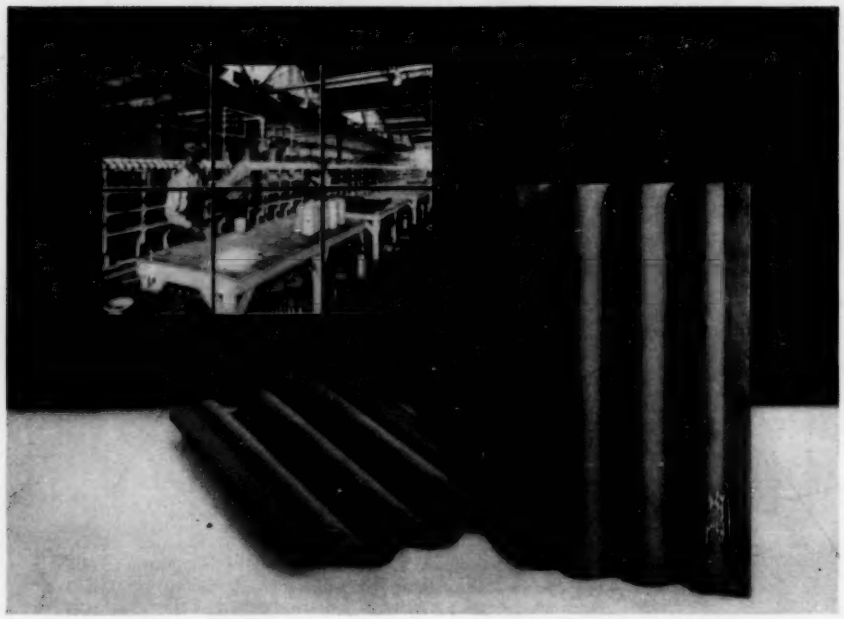

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EXPANSION MEASUREMENTS OF SEVERAL GLASSES BY MEANS OF A SELF-REGISTERING APPARATUS[1]

By Willi M. Cohn
(Translated by S. R. Scholes)

ABSTRACT

Applying an apparatus which registers photographically, and using quartz glass as control material, the expansion behavior of several glasses upon heating to temperatures above the softening point was investigated. It is shown that, with the help of the arrangement developed, even slight variations in the expansion-temperature curve, which might easily escape visual observation, can be detected. It is possible, by utilizing the results of these measurements, to regulate the annealing process of the glasses in the most useful manner.

I. Introduction

In recent years it has become increasingly apparent to the manufacturer as well as to the user of the products of the glass industry, that the heat treatment of the glass upon fabrication is most essential. It has been repeatedly shown that a knowledge of the expansion behavior of glass is of importance in making a sound product. Nevertheless, in the expansion-temperature curves of a glass recognizable inconstancies must arise which are of weighty meaning for its manufacture. On the other hand, curves of this sort permit conclusions as to the value of a submitted material.

It is not the purpose of the author to give a complete review here of the numerous studies which have been made on the expansion behavior of glass, but to cite only a few of the recent publications.[2] A summary of

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[1] Presented at the Annual Meeting, American Ceramic Society, Toronto, Ont., February, 1930 (Glass Division). Received December 24, 1929.

[2] Winkelmann and Schott, *Ann. Physik*, **51**, 730 (1894); Holborn and Grüneisen, *ibid.*, **6**, 136 (1901); S. English and W. E. S. Turner, *Jour. Soc. Glass Tech.*, **3**, 238 (1919); *ibid.*, **4**, 115 (1920); *ibid.*, **5**, 121, 183 (1921); C. G. Peters and C. H. Cragoe, Bur. Stand., *Sci. Papers*, Nos. 393 and 449 (1920); Lebedeff, *Trans. Op. Inst.* [Petrograd], Vol. 2, No. 10 (1921); Lafon, *Compt. rend.*, **175**, 955 (1922); S. English, *Jour. Soc. Glass Tech.*, **7**, 25 (1923); Schönborn, *Keram. Rundschau*, **33**, 17 (1925); C. G. Peters, Bur. Stand., *Sci. Paper*, No. 521 (1926); Klemm and Berger, *Glastech. Ber.*, **5**, 405 (1927); W. E. S. Turner, "The Constitution of Glass," Soc. Glass Tech. (Sheffield) (1927); S. English and W. E. S. Turner, *Jour. Amer. Ceram. Soc.*, **10** [8], 551–60 (1927); *ibid.*, **12** [12], 760 (1929); Berger, *Glastech. Ber.*, **5** [12], 569–97 (1928); Samsoen, *Ann. physique*, **9**, 35, 127 (1928); Grenet, *Le Verre*, **7** [2], 21–24; [3], 41–44 (1928) (*Ceram. Abs.*, **7** [9], 598 (1928)); W. E. S. Turner and F. Winks, *Jour. Soc. Glass Tech.*, **12**, 57–82 (1928); R. E. Proctor and R. W. Douglas, *Glass Ind.*, **10** [8], 193 (1929); A. Cousen and W. E. S. Turner, *Jour. Soc. Glass Tech.*, **12**, 169 (1928); F. Weinig and E. Zschimmer, *Sprechsaal*, **62**, 93, 855, 874, 889 (1929); L. D. Fetterolf and C. W. Parmelee, *Jour. Amer. Ceram. Soc.*, **12** [3], 193–216 (1929); R. J. Montgomery, *ibid.*, **12** [4], 274–303 (1929); Mutuyama, *Sci. Repts.* [Tohôku Imperial Univ.], **18**, 24 (1929).

the results of many investigations is found in Eitel[3] and also in Dralle-Keppeler.[4]

The apparatus used by the author for testing the expansion behavior of solid bodies will be briefly described, and a report on the expansion behavior of a few characteristic glasses will also be given.

II. Experimental Plan

For measurement of coefficient of expansion of solid bodies, two methods are chiefly considered. In one, the lengthening of a test piece in relation to the temperature is directly observed; in the other, the difference in expansion between a control material of known expansion behavior and the test piece under investigation is ascertained. Comparisons of these methods are given, *e.g.*, by Göpel,[5] Valentiner,[6] and W. M. Cohn.[7] The author also has reported on a direct method for measurement of expansion up to 1400°.[8]

Apparatus Used In the plan of investigation which was chosen for the present work, an apparatus was used originally developed by Leman and Werner[9] and Werner[10] in the Physikalisch-Technische Reichsanstalt. It was more recently improved by Braun[11] and Hoffmann.[12] This arrangement was further elaborated by the author for the undertaking of investigations up to 1400°C.[13] In this method, quartz glass is used as control material up to about 900°C, and Marquardt porcelain from there to 1400°C.

For simplification of the study, and for the recognition of effects in the expansion-temperature curve that would easily escape visual observation, the apparatus was equipped with a photographic registering device.[14]

The method of investigaton with quartz glass as control material and using photographic registration is described as follows:

Figure 1 is an illustration of the apparatus used.[15] The test piece under treatment (*A*, Fig. 1), stands between a stirrup, *Q*, of quartz glass and a rod of the same material, which extends into the shell, *R*, and by

---

[3] W. Eitel, "Physikalische Chemie der Silikate," Voss, Leipzig (1929).
[4] Dralle-Keppeler, "Die Glasfabrikation I," Oldenbourg, Munich and Berlin (1926).
[5] Göpel, *Handbuch Phys.* (Geiger-Scheel), **2**, 42 (1926).
[6] Valentiner, *Handbuch Expt.-Phys.*, **8** [II], 3 (1929).
[7] W. M. Cohn, *Ber. deut. keram. Ges.*, **9** [5], 239–99 (1928).
[8] *Ibid.*, *Z. Instrumentenk.*, **50**, 198 (1930).
[9] Leman and Werner, *Z. Instrumentenk.*, **33**, 65 (1913).
[10] Werner, *ibid.*, **44**, 315 (1924).
[11] Braun, *Z. tech. Phys.*, **7**, 505 (1926).
[12] Hoffmann, *Glasind.*, **34**, 84 (1926).
[13] W. M. Cohn, *Z. tech. Phys.* **11**, 118 (1930).
[14] *Ibid.*, **10**, 103 (1929).
[15] W. M. Cohn, *Ber. deut. keram. Ges.*, **10**, 271 (1929).

means of a soft spring is pressed against the test piece. The quartz rod transmits the difference in the thermal expansion of A and an equally long section of Q to a movable table, B, on which is mounted the prism, P_2, against the fixed prism, P_1.

When the test piece and control piece are heated, they expand in general unequally and the prism, P_2, is tipped against P_1. If a light beam of parallel rays falls out of a collimator in front of the prisms it is split into two beams, which are refracted through a telescopic system, and fall upon the mirror of a galvanometer, from whence they enter a photographic camera.

The tilting of the prism, P_2, upon heating the test and comparison pieces brings about a movement of the two light points on the photographic plate in the vertical direction. If the galvanometer is applied to indicate the temperature of the two pieces (test and comparison) there follows, upon heating, a turning of the mirror, which causes a swing of the two images on the plate in a horizontal direction. In this manner two curves are formed on a photographic plate. These, together with the help of standard curves derived from the following formula, give directly the expansion difference accompanying the temperature change.

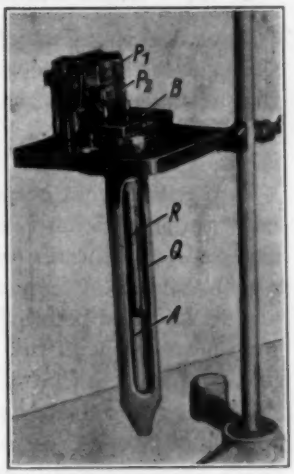

FIG. 1.—Apparatus for determining the thermal expansion of solid bodies. A, test piece, B, prism table, Q, quartz glass stirrup, R, guide-shell, P_1, fixed prism, P_2, movable prism.

$$\Delta l = \frac{r}{4F}\left(e_1 - e_2\right) + \Delta l_0$$

Where Δl = lengthening of test piece
r = lever of table B
F = focal length of auto-collimator telescope used as standard
e_1 and e_2 = distance between the two marks in the telescope at temperatures t_1 and $t_2 (t_1 < t_2)$
Δl_0 = expansion of a quartz glass piece equal in length to the test piece

The evaluation of the formula can be obtained either by calculation or by graphical methods. Thus there is obtained directly, in contrast to expansion measurements with photographic registration by other methods, the expansion of the test piece with an increase of temperature. For each temperature-interval the true or mean linear coefficients of expansion can then be obtained from the relation:

$$\beta = \frac{\Delta l}{L_0(t_2 - t_1)}$$

Where β = linear coefficient sought
Δl = measured lengthening of test piece upon heating from temperature t_1 to the temperature t_2
L_o = original length of test piece

Thus the expansion behavior of the investigated material can be followed throughout the entire range of heating; also very small effects within the substance which easily escape visual observation can be recognized.

III. Carrying Out the Research

Curves were first obtained for several glasses, using a thermostat filled with paraffin oil, in the temperature-interval, 20 to 200°C. Then an electric-wound furnace with chrome-nickel wire was used which possessed a zone of constant temperature throughout the full length of the test pieces and which could be heated to a temperature above 900°C. Temperatures were measured with two or three thermocouples of copper-constantan for low, and nickel-nickel chromium for high temperatures.

The length of the test piece was 50 mm. at the most; the rate of heating was about 2 to 3°C per minute, the heating of the furnace being regulated by a thermostatically-controlled fluid resistor. For each substance, curves for at least two test pieces were obtained. The limit of accuracy was ±0.5%.

IV. Results for Several Glasses

(1) Analyses As already indicated in the introduction, the aim of this investigation was not the exploration of a certain system of compounds, but in particular a proving of the new apparatus in its applicability for a glass-technical research. The following results are given for several typical glasses having very different compositions.

TABLE I

ANALYSES OF THE GLASSES EXAMINED

Material	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	K_2O	Na_2O	BaO	PbO	B_2O_3
Tube glass AI	66.25	4.24	0.10	7.78		3.95	12.29	5.20		
Mirror glass KII	73.34	1.03	0.09	12.08		0.23	13.13			
Lead glass LII	59.14	0.36	0.03	0.25		13.81	1.95	3.16	20.96	
Lead glass SII	59.19	0.39	0.03	0.39		11.72	3.00		24.99	
Lead glass PII	40.84	0.11	0.01	0.18		6.05	2.11		50.36	
Pressed glass KI	74.98	0.77		4.60		2.81	13.80	2.27		
Special apparatus glass FI	80.70	3.23	0.08	0.06	0.07		4.92			11.36

(2) Tubing Glass AI In Fig. 2, an original curve is repeated for the expansion behavior of the tubing glass AI for the temperature-interval, 20 to 200°C, compared with quartz glass. In

Fig. 3, is a characteristic curve for the temperature-interval, 0 to 600°C. In Figs. 2 and 3, the abscissas represent the temperatures (in consequence of different connections on the mirror-galvanometer the scale-graduation differs for the two temperature ranges) and ordinates

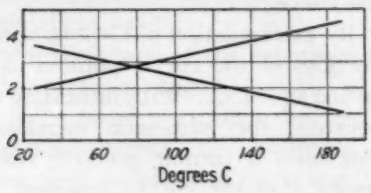

FIG. 2.—Expansion of tube glass AI in comparison with quartz glass; temperature interval 20–200°C.

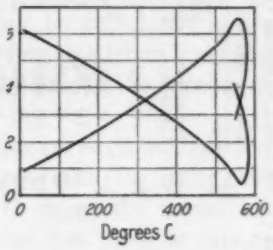

FIG. 3.—Expansion of tube glass AI in comparison with quartz glass. Temperature interval 0–600°C.

express the difference in expansion between the test pieces and quartz glass on an arbitrary scale.

Figure 4 gives the lengthening, as dependent upon temperature, in millimeters for a piece of material one meter long. This curve was drawn from the averages of a number of determinations made on two test pieces in the two temperature ranges.

In the temperature-interval, 20 to 200°C, glass AI gave identical curves for heating and cooling. No irregularities or irreversible changes in the length of the piece were observed in the curves after heating and cooling. Upon heating to higher temperatures than 200°C there appears, as is apparent from Figs. 3 and 4, a slight change of direction in the curve (point A_1).[16] On further increase of temperature, a straight-line slope of the curve results up to 403°C, then a new change of direction (point A_2) continuing as a rectilinear course.

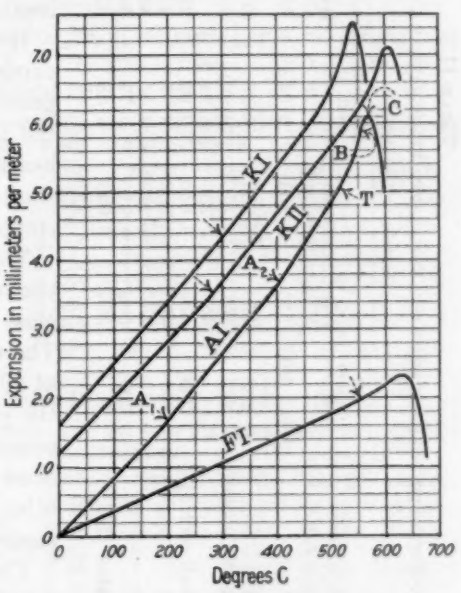

Fig. 4.—Expansion of several glasses. Temperature interval 0–700°C.

[16] The marking of this and the remaining variations is followed in the same manner used by Klemm and Berger;[2] similar also to that used by Dralle-Keppeler.[4]

TABLE II

CHARACTERISTIC POINTS IN THE COURSE OF THE EXPANSION-TEMPERATURE CURVES AND COOLING INTERVAL OF THE EXAMINED GLASS

Material	Inflection points (°C)		Transformation point			Softening point			Cooling interval		
			Temp. (°C)	Extension Δl (mm./m.)	Av. linear coeff. of expansion ($\beta \times 10^6$)	Temp. (°C)	Extension Δl (mm./m.)	Av. linear coeff. of expansion ($\beta \times 10^6$)	Temp. (°C)	Extension Δl (mm./m.)	Av. linear coeff. of expansion ($\beta \times 10^6$)
Tube glass (AI)	200	403	513	5.103	9.94	568	6.100	10.65	55	0.992	18.1
Mirror glass (KII)	282		550	5.080	9.08	602	5.924	9.86	52	0.884	16.2
Lead glass (LII) (badly cooled)	202		(378)	(3.572)	(9.42)	492	4.356	8.85	(114)	(0.784)	(6.87)
			450	3.936	8.74				42	0.420	10.0
Lead glass (LII) (well cooled)	205		450	4.056	9.02	492	5.052	10.28	42	0.996	23.8
Lead glass (SII)	200		445	3.992	8.97	477	4.772	10.00	32	0.780	24.3
Lead glass (PII)	238		437	4.152	9.47	461	5.360	11.65	24	1.208	50.3
Pressed glass (KI)	300		502	4.916	9.77	537	5.896	10.98	35	0.980	28.0
Special apparatus glass (FI)			555	2.040	3.68	625	2.360	3.77	70	0.320	4.6

At about 500°C, there gradually begins a pronounced increase in the rate of lengthening of the test piece with the mounting temperature, which goes over into a short, rectilinear section of the curve.

By extrapolation of the two straight portions of the curve, point T is obtained at 513°C. With increasing temperature the expansion increases in rate until a turning point is reached (point B of the curve), followed by a limited increase in expansion.

At 568°C a place is reached where the tangent to the curve is horizontal and a strong contraction takes place which can be followed up to about 600°C and which continues during cooling (Fig. 3).

If the heating of a glass is once carried beyond point C it is no longer possible, upon cooling, for it to retrace the same curve that it followed upon heating. After cooling a permanent shortening of the piece is evident when compared with its original length.

The irregularities in the course of the expansion-temperature curve of glass AI may be explained as follows: The change of direction at 200°C and at 403°C is made clear by postulating the existence of inflection points. In respect to the theoretical considerations in connection with these and the other irregularities in the curves the summary of Eitel[3] is referred to.

The important breaks in the curve above 500°C are conditioned by the transformation point T where the transition from brittle to plastic glass occurs. This phenomenon appears at about 500°C. Thus while an optical investigation of the glass would permit

the temperature of 500° to be accepted as making evident the effect, our measurement places this temperature definitely at 513°C.

The place of horizontal tangent, which was observed in the expansion-temperature curve for glass AI at 568°C may be called the softening point C of the glass. Between T and C, according to Klemm and Berger,[2] the sinking point B is assumed here as corresponding to the turning point in the curve.

From the shape of the expansion-temperature curve, it follows that in the temperature range 513 to 568°C a very important lengthening of the test piece takes place upon heating. Table II shows the magnitude of the cooling interval, the change in length of the test piece in this range in mm. per 1 m. length of piece, and the mean coefficient of linear expansion for the cooling interval.

Hence the annealing of glass upon manufacture must take place in the temperature range 513 to 568°C, and as a mean annealing temperature $\frac{513 + 568}{2} = 540$°C is established. (Respecting the course of the expansion-temperature curve for a badly-annealed glass compare with data given under material LII.)

In Table III, the increments of length, l, in mm. per 1 m. length are

TABLE III

ELONGATION IN MILLIMETERS FOR 1 METER LENGTH (ROD OR BAR) AT A HEATING FROM 0°C TO THE FOLLOWING TEMPERATURES

Material	0°C	100°C	200°C	300°C	400°C	500°C
Tube glass (AI)	0	0.848	1.700	2.700	3.680	4.964
Mirror glass (KII)	0	0.844	1.660	2.544	3.532	4.552
Lead glass (LII) (badly cooled)	0	0.960	1.900	2.840	3.668	
Lead glass (LII) (well cooled)	0	0.716	1.404	2.412	3.464	
Lead glass SII	0	0.872	1.728	2.664	3.576	
Lead glass PII	0	0.884	1.768	2.752	3.760	
Pressed glass (KI)	0	0.908	1.864	2.788	3.832	
Special apparatus glass (FI)	0	0.376	0.736	1.100	1.472	1.840

TABLE IV

AVERAGE LINEAR EXPANSION COEFFICIENT $\beta \times 10^{-6}$ AT HEATING FROM 0°C TO THE FOLLOWING TEMPERATURES

Material	0°C	100°C	200°C	300°C	400°C	500°C
Tube glass (AI)	0	8.48	8.50	9.00	9.20	9.93
Mirror glass (KII)	0	8.44	8.30	8.48	8.83	9.10
Lead glass (LII) (badly cooled)	0	9.60	9.50	9.47	9.17	
Lead glass (LII) (well cooled)	0	7.16	7.02	8.04	8.66	
Lead glass SII	0	8.72	8.64	8.88	8.94	
Lead glass PII	0	8.84	8.84	9.17	9.40	
Pressed glass (KI)	0	9.08	9.32	9.29	9.58	
Special apparatus glass (FI)	0	3.76	3.68	3.67	3.68	3.68

given between 0°C and different temperatures, which glass AI and the other investigated substances undergo upon heating below the trans-

formation point. In Table IV the mean coefficients of linear expansion are set forth, which have been calculated from the values in Table III. In Table II a further review is found of the position of the observed irregularities for the materials investigated and the amount of the lengthening Δl in mm./m., also the mean coefficient of linear expansion between 0°C and the temperature of the irregularity encountered.

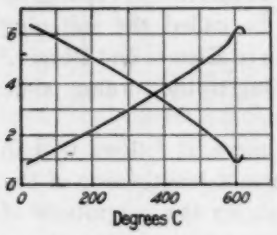

FIG. 5.—State of expansion of glass KII in comparison with quartz glass.

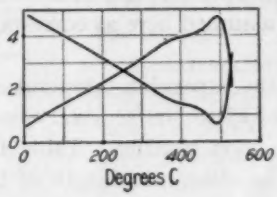

FIG. 6.—Lead glass LII, badly cooled.

Mirror Glass KII Figure 5 presents a photographic plate of the expansion behavior of this material in comparison with quartz glass in the temperature, interval 0 to 700°C. In Fig. 4 the mean values of the expansion are plotted against the temperature. In this curve there is found, in contrast to glass AI, only one change of direction at 282°C, which indicates the presence of an inflection point. The location of the transformation and softening points may be found in Table II. Both points lie at rather high temperatures in comparison with most of the glasses investigated. The other numerous data of the measurements are found in Tables II to IV.

Lead Glasses LII, SII, PII According to Table I in the analyses of lead glasses, the LII and SII are regarded as medium lead glasses, while PII is designated as a heavy lead glass.

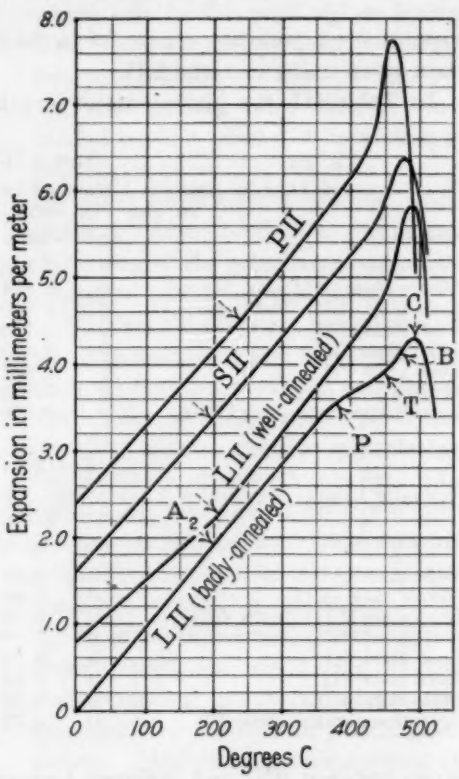

FIG. 7.—Expansion of several lead glasses. Temperature interval 0–700°C.

Glass LII This material, in the condition in which it was received, gave the curve of Fig. 6 in comparison with quartz glass, to which in Fig. 7 the curve of mean expansion in relation to temperature is drawn. A change of direction appears in this curve at about 202°C which again points to an inflection point. In contrast to the materials heretofore described, after setting out upon a straight-line course, the curve takes on a slight decrease of slope at about 358°C; near 450°C there may be observed a turning point, followed by a steeper slope. According to Klemm and Berger[2] the point at 378°C may be designated as P, while the turning point at 450°C is considered the transformation point, T. After passing through a second change of direction (point B) the curve attains a horizontal tangent (softening point C) at 492°C.

The expansion-temperature curve for glass LII shows a course varying from that of the other curves. It is characteristic of a badly-annealed glass obtained by too rapid cooling. If one refers the annealing temperature to point B, the parenthetical numerical values in Table II are obtained, which show serious disagreement with all similar research results. If point T at 450°C is taken as the transformation point, very small expansion values are obtained for this material (Table II) corresponding to the course of the expansion-temperature curve. Further, taking P as a basis, a very considerable temperature-difference is obtained between P and C, whereas the interval between T and C amounts only to 42°C.

If glass LII were reheated and then properly annealed, it would furnish a curve like those observed for the remaining glasses: Fig. 8 shows the original curve, while in Fig. 7 the evaluated curve is drawn, which was obtained after annealing. This curve has first a rectilinear slope and, after passing through an inflection point at 205°C, is straight up to the transformation temperature of 450°C. This curve also shows a softening point at 492°C. Reference is made to Tables II to IV for numerical values.

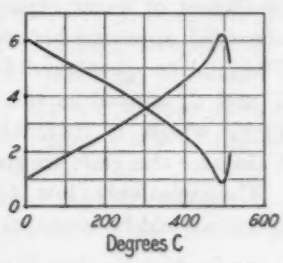

FIG. 8.—Lead glass LII, well cooled.

Notwithstanding the considerable difference in the course of the two curves for the badly-annealed and the well-annealed glass LII, the inflection, transformation, and softening points occur at the same temperatures. The slight differences for the temperatures of the inflection points in the two curves may be traced to the fact that the exact location of these points cannot be accomplished with the same certainty as in the case of the others. It is interesting to note that the badly-annealed glass shows a greater coefficient of linear expansion than the well annealed, an observation which is in agreement with the findings of English and Turner.[2]

Glass SII The expansion behavior of this material resembles that of LII in its well-annealed condition as shown in Fig. 9.

(Figure 9 is reproduced with a greater abscissa-scale than that of the curves previously shown in the same temperature range; in this manner it was sought to ascertain whether other inflection points would appear in this glass.)

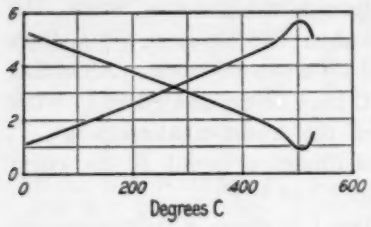

FIG. 9.—Lead glass SII.

The mean-value curve for glass SII is drawn in Fig. 7. Only one inflection point is observed for this material and transformation and softening points are easily recognizable. Table II contains the numerical values for the characteristic points. This substance has an annealing range less than LII. Further results of the investigation are contained in Tables III and IV.

Glass PII Figure 10 shows a curve of the expansion of this material in comparison with quartz glass. The mean-value curve of the expansion as dependent upon temperature is drawn in Fig. 7. In this case as before only one inflection point was observed. A feature of PII is the considerable lengthening which takes place between transformation and softening points. The highest coefficient of linear expansion which has been observed appeared between 0°C and point *C*. The small temperature difference between points *T* and *C*, as well as the very small annealing range which is available, is very unusual. Values for this glass are given in Tables II to IV.

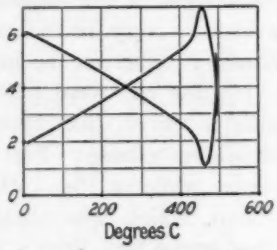

FIG. 10.—Lead glass PII.

The relatively low temperatures for transformation and softening points should be regarded as representative of the lead glasses investigated as well as the appearance of only one inflection point, a result which stands in agreement with the observations of the art and a series of special researches.

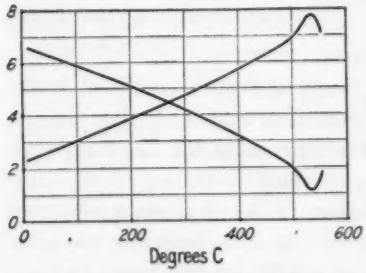

FIG. 11.—Pressed glass KI.

Pressed Glass KI As was apparent from the original curve of Fig. 11 and from the mean-value curve shown in Fig. 4, the existence of an inflection point at 300°C resulted during the work on this material. Transformation and softening points appeared in the usual manner, their respective temperatures lying some-

what higher than those observed with the lead glasses (see Table II). Tables III and IV contain the remaining numerical data.

Apparatus Glass FI An original curve for the expansion behavior of this glass compared to quartz glass is reproduced in Fig. 12, and also the mean-value curve is shown in Fig. 4. A remarkably low expansion with rising temperature is exhibited by FI as compared with the remainder of the glasses investigated. The course of the expansion up to 555°C is very uniform and signs of the existence of inflection points are not apparent. This finding agrees with Cousen and Turner[2] who similarly found no inflection points for borosilicate glasses.

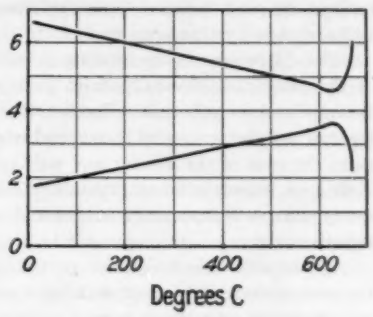

FIG. 12.—Special apparatus glass FI.

The amounts of the expansions, which were observed at the transformation and softening points, differ relatively little from each other (see Table II), the temperatures of the two last-named points being the highest encountered during this research. The annealing range is wide in comparison with those of the remaining specimens. Tables III and IV contain further numerical results.

Summary

It is evident, upon reviewing the results of these researches, that several irregularities are present in the course of the expansion-temperature curves in the case of all the glasses investigated. Through knowledge of the transformation and softening points, as they are compiled in Table II, it is possible to fix upon the temperature-interval within which a careful annealing of the glasses must take place.

For most of the glasses, only one inflection point can be established. Glass AI, however, shows the occurrence of two points of this kind and glass FI shows none.

With the help of the method described, it is possible to follow the expansion behavior of glasses depending upon the temperature up to the softening point and to recognize irregularities appearing throughout the course of the heating.

Acknowledgment The research work described in this paper was carried out with the support of the Notgemeinschaft der Deutschen Wissenschaft, which also donated the apparatus. The author wishes to express his appreciation to Dr. Eitel for permitting the use of laboratory space in the Institute. He also wishes to thank all the firms and individuals who have furthered the investigations by supplying specimens of material. For carrying out the analyses of the glasses, the author expresses his obligations to Fräulein C. Kraft and Fräulein Schmitz of the Kaiser-Wilhelm-Institut für Silikatforschung, Berlin-Dahlem.

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VARIATIONS CAUSED IN THE HEATING CURVES OF GLASS BY HEAT TREATMENT[1]

By A. Q. Tool and C. G. Eichlin

ABSTRACT

The variations produced in the heating curves of a glass by previously subjecting it to different heat treatments are often fully indicative of the nature of these previous treatments, and they also bear a relation to changes caused in numerous other characteristics of glass by this same means.

The differences in the heating curves arise from differences in the thermal properties of the glass and especially from changes in the magnitude and character of the exothermic and endothermic effects. The physico-chemical processes causing the endothermic are the reverse of those producing the exothermic, *i.e.*, the two effects are related as in the case of the similar and well-known phenomena observed at an inversion point such as is found in many crystals. They are, however, not confined to the usual relatively narrow temperature ranges and are also much more subject to undercooling and superheating.

Apparently this resistance to the physico-chemical processes increases rapidly as the temperature is lowered making it possible by rapid cooling to suppress the exothermic processes to a great extent and thereby prepare the way for relatively large exothermic effects on subsequent heating. Since the preparatory exothermic activity is insufficient, the endothermic effects in the heating curves of chilled glasses are never pronounced but may become quite large in these curves if in the annealing, the exothermic processes have the opportunity to continue their activity into the range of relatively low annealing temperatures.

During annealing the exothermic activity progresses more and more slowly toward a limit which may be advanced by reducing the annealing temperature. The physico-chemical condition which the glass would have if the limit for any given annealing temperature were reached is termed the equilibrium condition of the glass for that temperature and such an equilibrium is presumably kinetic in character. The continuous series made up of all these equilibrium conditions corresponding to the various temperatures in the annealing range is called the equilibrium sequence. It is shown that about any portion of such a sequence, a glass may be made to follow any number of apparently closed cycles and that in traversing these cycles it passes through a series of intermediate conditions which in general do not coincide with the equilibrium sequence except where this is practically insured by very thorough annealing at constant temperatures. At ordinary atmospheric temperatures, the usual type of glass is always in such an intermediate series since in ordinary practice it is impossible to extend the realizable equilibrium sequence to temperatures much below the lower limit of the practical annealing range. In this range, however, very low rates of cooling or heating will cause a glass to follow its equilibrium sequence with relative closeness after coincidence has once been practically established.

In view of the present insufficient knowledge concerning the constitution of glass,

[1] Publication approved by the Director of the Bureau of Standards, U. S. Department of Commerce. This article includes many of the salient points discussed in a paper, "Some Variations Caused in the Physical Properties of Glass by Heat Treatment," read at the meeting of the American Ceramic Society at Atlantic City, N. J., February, 1924. It also contains additional data bearing on those points. This article will also appear in the Bur. Stand., *Jour. Research*, April, 1931. Received January 12, 1931.

the particular processes involved in these changes of physico-chemical condition are presumably too complex and varied for analysis. Apparently, however, the activity of the exothermic type gives rise to a series of molecular readjustments which often limit the ability of the glass to reach other conditions having possibly greater stability especially at relatively low temperatures. In some cases these readjustments may insure a greater permanency to the vitreous state as long as the glass is not heated above the temperatures producing them. A relatively clear conception of these readjustments and of the general behavior of glass in the annealing range may be gained from a consideration of the changing conditions in any physico-chemical system, *e.g.*, a solution, where the equilibrium condition depends upon the temperature but normally does not change simultaneously with it. From the standpoint of investigating certain properties and characteristics, systems like glass yield advantages since their reaction rates are low and give opportunity for many observations during any change of importance and also since the thermal effects caused by superheating and undercooling are readily detectable.

The relation which the changes in physico-chemical condition bear to certain problems in practical annealing is also considered, and from the discussion it is evident that annealing procedures may often be manipulated so that the resultant changes in certain properties (notably the refractivity) will cause a glass to meet standards of requirement which it would normally fail to reach if annealed according to a fixed schedule prescribed for its general type. Although the tolerances of present-day standards are so lenient that adjustments of this character are seldom required or employed, it is believed that the time is rapidly approaching when an extended use will be made of them especially in those cases where a highly-standardized production of optical instruments of great precision is attempted. More important from the optical instrument standpoint, however, is the need of always annealing a glass in such a way that the physico-chemical condition is fully uniform throughout the whole piece or blank from which an optical part is produced. In many cases gradients no greater than a small fraction of a degree will, if they exist during annealing, produce nonuniformities which cause greater disturbances than strains of considerable magnitude.

I. Introduction

In a previous article[2] attention was called to the fact that the form of the heating curves obtained on glasses that have been chilled is different from that found on the same glasses after they have been well annealed, and also that this difference in curve-form probably indicates the occurrence during annealing of some decided change involving physical and chemical readjustments in the glasses. It was concluded that these readjustments, when induced by annealing, usually effect a shift of the physico-chemical equilibrium of a glass to those conditions which are normal at lower temperatures, although it was found that displacements in the opposite sense can easily be accomplished by appropriate heat treatments. It was also noted that the equilibrium reached depended on the annealing temperature, and, as a consequence, it appeared that any temperature gradients that may exist during annealing will produce corresponding local variations in the physico-chemical condition and thereby cause the glass to be inhomo-

[2] *Jour. Opt. Soc. Amer.*, **4**, 340 (1920).

geneous. For this reason as well as for the avoidance of strain, temperature gradients should be eliminated, insofar as practicable, when annealing high precision instrument glasses.

For some of these instruments it is evident that glass, besides possessing high degrees of structural homogeneity, should also be in a stable physico-chemical condition. This stability is increased when the temperature corresponding to the equilibrium is lowered; consequently, adequate annealing at temperatures somewhat lower than those usually employed is, at times, necessary. It was pointed out, however, that in general it is unnecessary, if not practically impossible, to reduce the usual type of glass to conditions of equilibrium corresponding to those temperatures at which glass is ordinarily employed. This holds good for most glasses in common use because the rates at which the changes in equilibrium take place always become very slow even at moderately low annealing temperatures; while at temperatures approaching those of ordinary service, these rates are almost always negligible even if the glass is rather poorly annealed.

Additional evidence is given here showing that from a practical standpoint it is not only impossible to reduce a glass of the usual type to any vitreous equilibrium in the temperature range of ordinary service, but that it is also difficult while cooling such a glass to maintain conditions which correspond[3] fully to any of the equilibrium conditions which may be easily reached in the upper annealing temperature range. In other words, glass is seldom, if ever, in physico-chemical equilibrium at any temperature below the range where perceptible deformations are easily produced, since its actual condition usually corresponds more closely, although never exactly, to an equilibrium that may be reached only by a sufficient heat treatment at a temperature somewhere within the range of easy deformability. If its physico-chemical condition is uniform and remains practically unchanged, glass may, however, be used indefinitely without detrimental effects arising from differences between the actual and the equilibrium temperatures.

In a glass of homogeneous chemical composition, the physico-chemical condition (or constitution) and any lack of uniformity in this condition in a given specimen (or between different specimens from the same melt) are determined chiefly by the treatments to which the glass was subjected in the molding and annealing temperature ranges. Neither the physico-

[3] Whenever it is said that the physico-chemical condition at the actual temperature of the glass corresponds to another condition in which it may be found to exist at some other temperature, the word "correspond," as used here, is intended to convey the idea that the two conditions are the same in every respect except that the material has undergone those normal changes in density, heat content, etc., which accompany every such change in temperature but which do not involve chemical reactions and changes in state or degrees of solution and aggregation.

chemical constitution nor its possible lack of uniformity is, however, materially affected by the magnitude of the elastic strains present at any time. Both the constitution and uniformity are subject to changes whenever the glass is being annealed and in being changed they affect both the distribution and apparent relaxation rates of the strains. When these changes in the constitution of a glass are produced by means of a suitable annealing, the properties can in certain cases be made more desirable, especially since the resultant increase in uniformity often reduces much of the variation in properties sometimes found even within a single small piece of glass. Consequently, it was suggested in the article cited that annealing a glass intended for optical or other precision instruments involves more, in general, than the removal of the stresses which cause the birefringence commonly used to indicate the quality of annealing.

In a later paper[4] it was stated that a gradual increase in the treating time at any given temperature produces a progressive change in the heating curve-form until a physico-chemical equilibrium for that particular treating temperature has been reached by the glass. It was also pointed out that for glasses in such equilibria, the form of the curves changes as the treating temperatures corresponding to the equilibria are varied; and that these variations in the treating procedure (caused by changing either or both the temperature and the period of treatment) produce changes in certain physical properties of the glass that can be coördinated to a certain degree with the observed changes in form of the heating curves.

Since it was also found that the condition approached at any given treating temperature always appears to be practically the same regardless of whether the glass was originally in equilibrium at a higher or a lower temperature, it was concluded that in most cases long and continuous series of equilibrium conditions can be definitely established. (Fig. 2.) It was also concluded that by holding a glass successively, for a sufficient time, in every small temperature interval within the corresponding wide temperature range it may, when either heated or cooled, be made to follow its particular series of equilibrium conditions throughout this extensive temperature range. Such a range is often much wider than the practical annealing range of a glass. Although the temperature limits between which this series of equilibrium conditions can be established in practice have not been definitely determined for any glass, it seems certain that in many cases such ranges extend from temperatures well above to temperatures considerably below the commonly accepted limits of the seemingly anomalous effects observed in the expansion and the heating curves.

Although some of the more interesting data and a few of the more illustrative curves have from time to time been published it has naturally

[4] *Jour. Opt. Soc. Amer.*, **8**, 419 (1924).

been impossible to present more than a small portion of the results on which the above conclusions were based. In this paper, therefore, some additional data and a further discussion of the general subject are given. It is believed that all these new data are in full accord with the above conclusions and confirm, in part, some of the opinions advanced by other investigators, notably Marchis.[5]

The chief object of this paper is, however, to show some of the changes appearing in the heating curves obtained on samples taken from time to time from a glass while it is, by continued treatment, being gradually advanced toward equilibrium at a given treating temperature from a condition of practical equilibrium corresponding to some other temperature.

II. Method of Obtaining and Presenting the Heating Curves

For descriptions of the methods and apparatus employed see articles already cited.[6] With the modified apparatus now used, the temperatures of both the glass and the neutral body and the difference between these temperatures can be easily determined by separate measurements. The following more detailed information concerning the measurements and the resulting graphs is, however, necessary for a satisfactory interpretation of the data presented.

Description of Measurements

In curve No. 14, Fig. 3, the difference between the ordinates for any two points on the curve represents the change observed in the temperature difference between a 1.5-gram sample of granular glass[7] and a neutral body[8] having equal volume, packed in close contact, and heated at a steady rate of approximately 6°C per minute[9] through the temperature range, limited by the

[5] L. Marchis, Les Modifications Permanentes du Verre et le Deplacement du Zero des Thermometres, Paris, 1898.

[6] In addition to the articles mentioned, see Bur. Stand., *Sci. Paper*, No. 358 (1920) entitled, "Concerning the Annealing and Characteristics of Glass."

[7] Granules of glass having an average equivalent diameter of about 1 mm. were used because the needed immersion and contact for the thermocouple were thus obtained with less difficulty than is encountered by using solid samples and with none of the peculiar effects found upon employing finely-powdered glass.

[8] The neutral bodies used in these experiments were composed of fine granular alundum, although other materials have at times been employed and have usually been found suitable if they are free from disturbing heat effects in the required temperature ranges.

[9] This rate of heating has been found to give good results in determining the relative magnitudes of both the exothermic and the endothermic effects obtained with different samples. With all other conditions of the tests kept practically the same, it is possible, by maintaining the heating rate reasonably constant throughout a series of tests, to compare the curves obtained for the various samples tested and to have a reasonable assurance that any differences in curve-form noted are the result of differences in the previous heat treatment or in the character of the glasses. As shown in

temperatures indicated by the abscissas of the two points being considered. Thus the abscissas represent the temperatures of the glass as it is being heated while the ordinates, if their zero is established, show the corresponding differences between the temperatures of the glass and neutral body.

It is unnecessary, however, to establish this zero in most cases since the actual temperature of the glass may be either higher or lower than that of the neutral body due to inability to control the direction of the heat flow in the furnace. This difference in temperature of the bodies can be kept small, in most cases, by properly placing a thermocouple in carefully packed bodies. It showed no great variation from test to test on samples of the same glass. When this difference is small it appears to be caused chiefly by the differences between the heat capacities and conductivities of the glass and neutral bodies.[10]

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a previous paper (see footnote 4) this method of comparison also makes it possible to determine the period of treatment required at a given treating temperature either to bring a glass into approximate equilibrium there or to cause it to show the heat effects corresponding to any of certain intermediate conditions through which the glass must pass in approaching equilibrium at this temperature and which may or may not be practically identical with approximate equilibrium conditions for certain other temperatures.

[10] This view is strengthened by the appearance of an appropriate change in the temperature difference whenever another glass with a different thermal capacity is tested under the same conditions. Furthermore, in an investigation of this kind it is impossible to eliminate all the troublesome effects encountered in the use of differential thermocouples, especially when a long series of tests is being made. If the thermocouple has been used for some time and the wires have become contaminated or otherwise changed in character, the two parts of the differential thermocouple may become dissimilar and cause the introduction of possible errors which, although relatively insignificant in actual temperature determinations of these tests, become troublesome when they enter into the observed temperature differences whose magnitudes are never more than a few degrees. Such errors in these differences may reach a degree or more, although if care is taken they seldom become so large. Moreover, they never vary disturbingly in the temperature range covered by these particular tests during the time required for obtaining the data for limited series of curves; consequently, the variability of the error in the differences between the ordinates of any comparable pairs of points on different curves is relatively small.

Since these ordinate differences are comparatively free from error and are fully indicative of the change in curve form, it is possible in most cases to ignore the magnitudes of the ordinates which represent the differences in temperature between the neutral and glass bodies. Preferably, therefore, in considering a series of these heating curves, they should all be made to coincide at some temperature point (see Fig. 4) where it is probable that the glass has, in every case, reached practically the same physico-chemical conditions. If confusion is caused by intermingling of a large number of curves, the curves may be presented one above another in some desirable order (see Fig. 3). In the latter case, if critical intercurve comparisons seem desirable, reference points may be taken at some chosen and identical temperature on all of the curves. To determine the necessary ordinates at the temperatures where the comparisons are to be made, these ordinates should in every case be determined in relation

III. General Characteristics of the Heating Curves

The typical appearance of a heating curve for chilled glass, curve 27, Fig. 7, is radically different from that for annealed glass, curve 38, Fig. 9.

Curve 27 shows the presence of an exothermic effect between 350°C and 550°C. In this range the curve rises rapidly from its initial level to a maximum and then, at somewhat higher temperatures, goes into a steep decline to a lower level. This decline indicates either or both of two effects: an endothermic effect or a relatively rapid change in the specific heat and conductivity of the glass.

Curve 38 shows no exothermic effect but the decline to a minimum is so marked that the presence of an endothermic effect is definitely established.

Granting the presence of these effects, it appears that both the exothermic and endothermic effects must be associated with certain changes in the constitution of the glass and that these constitutional changes are to a great extent responsible for any change in the thermal properties that is indicated by the form of the curves. On these assumptions a hypothesis concerning both the behavior of glass when heat-treated and the characteristics of the heating curves presented in this paper will be developed.

Characteristics of Heating Curves

The exothermic effect occurs when a chilled glass is heated because this glass is in a series of unstable conditions corresponding more nearly to the equilibria attainable at temperatures above the point where the curve maximum occurs than they do to those equilibrium conditions which the glass is approaching while passing through the temperature range below this curve maximum.

Glass assumes unstable conditions because the chilling treatment produced an undercooling, the exceptional magnitude of which may be visualized in this way. *I.e.*, this equilibrium temperature in falling during the chilling treatment (see curves A^1 and B^1, Fig. 1B) lagged farther and farther behind the actual temperature of the glass as the cooling progressed and became practically stationary much sooner (relatively speaking) than the latter and at a point which was well above the usual annealing range where equilibrium conditions are normally approximated as a result of ordinary annealing treatments.

On reheating the glass from room temperature, this instability first becomes evident when the rise in actual temperature has proceeded far enough to allow an appreciable activity of those exothermic processes which were suppressed by the chilling and which, under the favorable conditions of a sufficiently slow cooling and until too greatly hampered by the increasing rigidity of the glass and other unfavorable conditions, would ultimately

to the reference point on the curve to which they belong. These relative ordinates for any curve may then be compared with those similarly determined for any other curve in its series.

have caused the equilibrium temperature to fall much further and would have assisted correspondingly in the establishment of definite physico-chemical equilibria in this temperature range of temporary instability.

Owing to the increasing activity of these processes as the temperature rises, the constitution of the glass changes for a time more and more rapidly and, as a result, the exothermic effect increases for a time. This continues until the changing condition of the glass approaches so closely to the equilibrium condition corresponding to the actual transient temperature attained

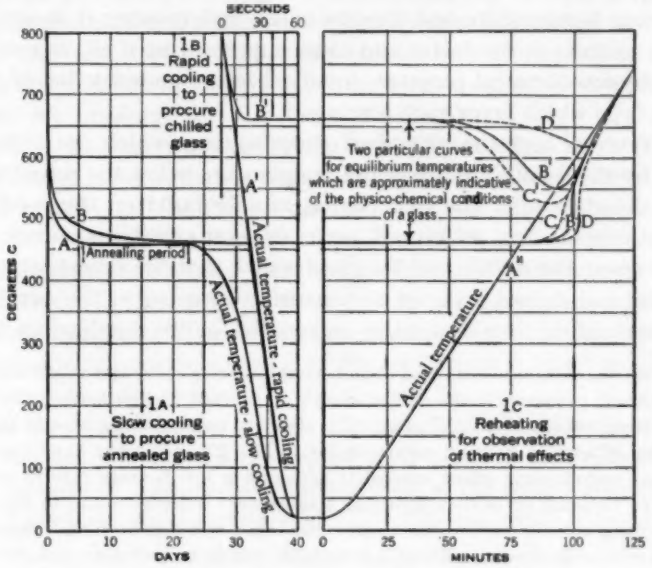

FIG. 1.—An approximate representation of the courses of the actual and equilibrium temperatures during the processes of annealing, chilling, and testing glass samples. (See complete explanation p. 308)

that the process activity reaches its maximum while the exothermic effect and heating curve pass through their maxima. Beyond this point further heating soon causes the rising actual temperature of the glass to reach, pass, and, so long as its rise continues, to remain in advance of the more slowly changing equilibrium temperature which after the coincidence is also rising.

In other words, during the chilling treatment this equilibrium temperature was falling more slowly than the actual temperature of the glass (see Fig. 1B) and, when the glass was reheated for testing, it resumed falling at an appreciable rate as soon as temperatures were reached that made the instability of the glass apparent (curve *B'*, Fig. 1C). As the actual tem-

perature of the glass continued to rise (curve A'', Fig. 1C) this decrease in the equilibrium temperature continued until the two temperatures momentarily coincided.[11] Presumably this occurred before the curves in Fig. 4, for example, fell noticeably below the first level.

After this coincidence of the two temperatures at the crossing of curve A'' by B' it is assumed that the actual temperature again led as it did during the chilling treatment and that the glass at the moment of coincidence was changed from the undercooled to the superheated state. That is, if the actual temperature of a glass can be made to fall more rapidly than the equilibrium temperature and thereby cause undercooling it should also be possible to make it rise faster and cause superheating if all, or even a part, of the physico-chemical processes involved in the undercooling of the glass are of a type which favor such a reversal.

This reversal and the attendant superheating, which are indicated in Fig. 1C by the lag of the equilibrium temperature below the actual temperature of the glass after the coincidence, rapidly build up the condition for an endothermic effect which will occur as soon as a temperature range is reached where the mobility of the glass is such that the superheating can no longer be maintained without an excessive increase in the heating rate. The superheating then disappears so rapidly (as the equilibrium tempera-

[11] A lower heating rate than that chosen for the heating curve test would have allowed the exothermic processes in the chilled sample to proceed further toward the equilibria of lower temperatures (curve C', Fig. 1C). Such a test condition should increase the exothermic effect in a heating curve similar to No. 27 and might have increased the subsequent endothermic effect somewhat although a low heating rate is unfavorable both to the building up of corresponding temperature differences and to superheating. If the heating rate is too low, an exothermic effect will not be found since the heat liberated will be dissipated without a detectable rise in temperature and, for the same reason, an endothermic effect may not be observed, *i.e.*, the heating curve will drift gradually from the first into the second level. On the other hand, if the heating rate could be made great enough it should be possible as indicated by curve D', Fig. 1C, to suppress almost completely the exothermic effect shown by heating curve and to delay the endothermic effect (in a glass similar to melt 431, for instance) until temperatures higher than those of the maxima for this effect (see curves 27 and 28) are reached. In reality, heating at a rate equal to or greater than that of the cooling previously employed in chilling a glass should practically eliminate all trace of an exothermic effect and possibly most of the endothermic effect in the curves because that would allow so little time for those changes in condition which are necessary for these effects.

With annealed glass, however, increasing the heating rate (see curve D, Fig. 1C) should always increase the observable endothermic effect. It should also increase the temperature for the maximum of this effect but because of the rapid rate at which glass softens at high temperatures such a shift will never be large. Slight shifts which are not entirely traceable to errors in temperature measurements have, however, been observed. Decreasing this rate in the heating curve test of annealed glasses (curve C, Fig. 1C) should decrease the endothermic effect and lower the temperature for its maximum.

ture gains on the actual) that an abnormal heat absorption becomes evident over a narrow temperature range. That is, whenever, this superheating and its rate of disappearance are large enough the resulting abnormal heat absorption will cause a steep decline of the heating curves shown in the last nine figures to a more or less well-defined minimum before the second or final level portion of the curve is attained.

To a great extent these processes responsible for the endothermic effect are undoubtedly the reverse[12] of those that were previously moving the condition of the glass from approximate equilibrium at high temperatures toward those conditions which correspond more or less closely to equilibria at lower temperatures. Actually the vanishing exothermic effect probably overlaps the endothermic effect to a considerable extent if several types of processes are involved.

Since the temperature range of the endothermic effect as shown by the heating curves is much higher than that of the exothermic effect, it follows that the mobility of the glass is increasing at a much greater rate in the temperature range of the former. Consequently it is to be presumed that the endothermic processes have at these higher temperatures a much greater rate of increase in their activity than the exothermic processes have at the lower temperatures. This assumption gives an explanation for the relatively narrow temperature range of the endothermic effect as compared with that of the exothermic.

It will be noted that the minima for curves 27 and 38 both occur near 600°C, but that the one for the chilled glass is not so well defined as that for the annealed. The relative indefiniteness of the chilled glass minimum (curve 27) is generally observed in all chilled glasses and is to be ascribed to

[12] It is to be assumed, of course, that all the processes do not reverse at the same time and temperature and also that the reversal temperature of a given process is not at all times the same, since in general such a temperature will often depend not only on the process but also on the general condition of the glass and the degree to which the process had advanced. Some processes may first become active in a cooling glass when it has cooled to a certain temperature and, although they may continue active at still lower temperatures so long as they are not completed, the ultimate degree of completion may never exceed that which might have been attained at the starting temperature. The reversal temperatures of such processes will generally be as high as those of starting. Examples of such reversible processes would be the retarded crystallization and the liquefication of relatively insoluble components. With other processes the attainable degree of completion may increase continuously as the temperature of the glass falls or rises, and in such cases the reversal temperatures of the processes will generally be lower on cooling and higher on heating than the starting points and will be determined mainly by the advance the corresponding processes have made. This latter type of process is considered to be the chief cause of the heat effects observed. It is, of course, evident that at all temperatures there may be simultaneously active both exothermic and endothermic processes, especially when an unannealed glass is being heated. The observed heat effects are due, therefore, to a preponderance in either number or effectiveness of the one or the other type.

a reversal of a majority of the exothermic processes before they were completed to the extent required to produce even an approximate equilibrium at any temperature[13] below that where the endothermic effect begins. That is, the reversals were brought about in reheating this chilled glass before the exothermic processes had time to produce the conditions necessary for a marked superheating. In fact, it is possible that some of the more important of these processes are so sluggish in their activity during the reheating that they had not reached a condition requiring their reversal until the actual temperature of the glass had reached or exceeded 600°C. Throughout the range of the endothermic effect in the curves for the chilled glasses such unreversed processes were therefore exothermically active and were reducing the observed endothermic effects caused in the curves by the more advanced processes which were reversed at lower temperatures.

In the case of the annealed samples of this glass, however (see curve 38), the previous annealing treatment gave all exothermic processes the opportunity to proceed much further toward establishing equilibria corresponding to temperatures below 500°C. Consequently, when these samples were reheated, both the number of process reversals from neutral and exothermic to endothermic action at temperatures below 550°C and the total effect of the resultant endothermic processes as the superheating began to diminish rapidly near this temperature were greatly increased. The number of exothermic processes and their effect at temperatures near 600°C were correspondingly reduced.

Since it is assumed that the number of reversals is always larger in annealed than in chilled samples at temperatures just below a limit which corresponds in this particular glass to 550°C and also since this increase is always gained from the relatively sluggish processes, it follows that on reheating the annealed samples a much greater superheating and a corresponding larger endothermic effect should always be expected as the thoroughness of annealing increases.

To a great extent the difference which exists between the first and second levels of these heating curves is doubtlessly attributable to changes in specific heat and thermal conductivity. The specific heat, for example, may be changed rapidly and appreciably as the temperature changes if the exothermic and endothermic effects are associated with processes which so change the physical and chemical associations and arrangements of the molecules and ions that the types, numbers, degrees of freedom, etc., of these units are rapidly decreased or increased. Thus it would appear that the second level, since it is in the higher temperature range where the specific heat is normally greater, should lie below the first as it actually does.

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[13] This is about 550°C for the glass used in obtaining the curves now being considered.

Also it would seem that a chilled glass should have a higher specific heat in the temperature range of the lower level than an annealed glass.

Acting alone, this difference in specific heat, if it exists, should make the difference between the first and second levels greater for the annealed glasses than for the chilled. Actually, however, this condition is seldom observed, since these differences between the levels are (for a given glass) usually found to be almost equal for all samples regardless of their previous heat treatment except that in those cases where the samples have been severely chilled, they, contrary to the above deduction, yield differences which are relatively quite large. (See curves 2, Fig. 4, and 27 and 31, Fig. 8.)

These results make it appear that in obtaining a heating curve the effect of the increased specific heat of a chilled glass is generally balanced and, in the case of severely chilled glasses, completely outweighed by the effect of an equally possible increase in the thermal conductivity. This would seem to indicate that the thermal diffusivities of such chilled glasses at atmospheric temperatures are relatively large.

This comparatively large difference between the initial and final levels of a curve on severely chilled glass may also be caused by some of the exothermic processes becoming active before the first observations are taken, *i.e.*, soon after the glass reached 100°C. While this seems relatively improbable as an explanation for all of the increase in the difference, it is evident that any heat released by such processes as might be active in this range would reduce the apparent specific heat by raising the curve level.

At this point it must also be noted that below 300°C no really significant departure from the initial level by the curves referred to was observed; and while this may be considered as indicating that no exothermic processes were active in that range, it is also an obvious cause for overlooking such an activity if it were present.

In well-annealed glasses, on the other hand, it may be safely assumed that processes of this sort are so nearly completed or are so thoroughly inactive in this range of relatively low temperatures that the initial level of the curves is determined almost entirely by the real specific heats and thermal conductivities of the samples. At and near the final level, however, both the chilled and annealed glasses are assumed to be approaching the equilibria corresponding to each passing temperature so rapidly that very little difference is to be expected between their respective conditions. Their curve levels should consequently almost coincide in this range of higher temperatures. Until the sintering range is almost reached, the curves on chilled samples should be slightly higher, since some vestige of activity on the part of the exothermic processes probably still exists while the activity of endothermic processes which are predominant at these temperatures has not yet become quite so great as in the annealed samples.

As in the range of the initial level for chilled glasses the activity of the

processes again affects the apparent thermal capacity and conductivity; but since the predominant activity, especially in annealed glass, is now endothermic, the effect it has must be either an apparent increase in the specific heat or an apparent reduction in thermal conductivity which is the opposite of the effect of the exothermic activity at the initial level.

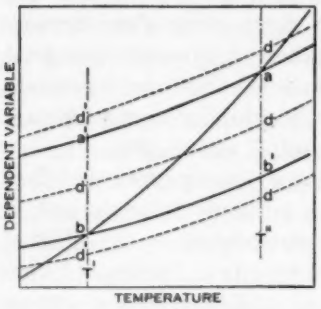

FIG. 2.—A representation of the cyclic changes in the physico-chemical condition of a vitreous material. (See discussion in footnote 12.)

As a result of the influence of these exothermic and endothermic effects the differences between these two levels probably always indicate a greater change in these two properties than that which actually occurs; that is, between these two temperature ranges the change in specific heat, for example, is generally greater than the corresponding change in the "true specific heat."[14]

With the possible exception of equilibrium curves such as *ab*, lines drawn in a plane and representing the various sequences of conditions must be considered as mere projections of curves in a multi-dimensional space since, even with the pressure constant, one dependent variable determined on a single property of the material is presumably insufficient to determine the course of such changes in condition unless the equilibrium sequence is being followed. For that reason, as indicated in the footnote, the lines *dd'* in particular must be considered as projections of curves which in general do not cut the line *ab*.

[14] The terms "true" and "apparent" specific heats are used here merely for the purpose of making clear a distinction which exists between a specific heat that is not, and one that is, increased or decreased by endothermic or exothermic effects which are anomalous in the nature of this coefficient and whose presence (since they are often small and may not be confined to definite and narrow temperature ranges) is in many cases unsuspected. Such a clarification seemed desirable from the standpoint of promoting a better understanding of the variable results which are possible in all measurements on the different thermal coefficients of the various materials possessing indefinite effects of this sort. If these effects are caused by certain internal processes which, in establishing equilibria, consume considerable periods of time in reaching the required degrees of completion which (together with the velocities of the processes) are determined by the temperature and the general condition of the material, it follows that their relations to such variations in these coefficients can be simply illustrated since the conceptions and facts involved are practically those discussed in the usual text-book presentation of "The Influence of Temperature upon the Heat of Reaction." (See Nernst's Theoretical Chemistry, p. 599, English translation of the 6th ed., 1911.)

For instance, consider a sample of glass, having a mass of one gram and a length of one centimeter, which is in physico-chemical equilibrium at the temperature, T'', where, although the changes are assumed to occur not too rapidly, such a condition can be reached in a reasonable time; *i.e.*, T'' is chosen in the usual annealing range. If the glass is cooled at a sufficiently rapid rate from this temperature through an inter-

val, $T''-T'$, there will be a contraction, C'', and a heat emission, S'', while the glass passes through that normal series of conditions, aa' in Fig. 2, which in this interval "corresponds" to the equilibrium condition at T'' (see footnote 3). Under these circumstances S'' and C'' are changes caused entirely by processes which follow instantaneously any temperature change. If the glass is now held at T' until physico-chemical equilibrium is established at that temperature there will occur a further contraction, c', and heat emission, s'. The particular values of the contractions and heats of reaction which may occur at T' are those, therefore, which accompany the specific change, $a'b$, from a condition corresponding at that temperature to the equilibrium at T'' to equilibrium at T'.

If, however, the glass is cooled so slowly (in the upper part of the annealing range such a cooling may be made quite rapid but in the lower part it must be extremely slow) that it passes only through the series ab of equilibrium conditions, the contraction and heat emission, C and S, respectively, will be observed for the interval, $T''-T'$; and in this case C and S are caused not only by the instantaneously responsive processes but also by those which require time and which were responsible for c' and s'. Since the equilibrium conditions at T'' and also at T' are presumably the same for both cooling methods (except in certain cases not considered here) it follows that $C = C'' + c'$ and that $S = S'' + s'$.

If the glass now in physico-chemical equilibrium at T' is heated with sufficient rapidity to T'' the resultant expansion and heat absorption will be C' and S', respectively, while the glass passes through the normal series of conditions, bb', which corresponds within this interval to the condition of equilibrium at T'. If the glass is then held at T'' until physico-chemical equilibrium is established at that temperature by passing along $b'a$, a further expansion, c'', and heat absorption, s'', will occur. These are only particular values of the expansions and of the heats of absorption required in general by the reactions which may occur at T'' in producing equilibrium at that temperature, since they are those values associated with the specific change from a condition corresponding at that temperature to the equilibrium at T' to equilibrium at T''.

If the rate of heating is so low, however, that the series ba of equilibrium conditions is followed, an expansion and heat absorption will be observed which, disregarding signs, will equal the contraction, C, and heat emission, S, observed during the slow cooling over the same interval. Then since $C = C' + c''$ and $S = S' + s''$, it follows that $C'' - C' = c'' - c'$, and $S'' - S' = s'' - s'$.

In the above, therefore, $S''/(T'' - T')$ and $S'/(T'' - T')$ are, in general, different although both may be regarded as average true specific heats for the same interval $(T'' - T')$. These particular values of the coefficient are to be obtained only by bringing the glass to equilibrium at the starting temperatures before the tests are begun. According to the general assumptions made, however, there must be at any temperature, T, a great number of other possible intermediate conditions such as are represented by various positions on $a'b$ or $b'a$, for example, which a glass might possess whenever a test is started. Corresponding to each of these initial intermediate conditions there is within any temperature interval beginning at T an average true specific heat which differs, in general, from those corresponding to all the others. These values of a thermal coefficient are met whenever a glass follows a series of intermediate conditions like that exemplified by any dd' in the interval $T'' - T'$. (It should be noted that such a series of intermediate conditions yielding a true specific heat may or may not correspond to some condition in the equilibrium series either within or without the section ab. That is, the coincidence of two such series which is indicated by an intersection of the representative lines in the accompanying diagram may be only apparent

IV. Annealing and "Disannealing"

The conceptions based on the progressive change in form of the heating curves are recapitulated as follows:

(1) As the temperature of a glass in the annealing range is reduced very slowly, its physico-chemical equilibrium changes correspondingly because of the activity of a number of slow exothermic processes. In the case of a more rapid cooling, these processes are suppressed but resume activity whenever the glass is reheated at a rate which is lower than that of cooling, causing a detectable and an apparently abnormal exothermic effect.

(2) The exothermic effect usually observed on cooling curves is caused by the cessation of the activity of these exothermic processes as undercooling begins.

(3) All of those processes which may be retarded by chilling and which are the cause of the relatively large exothermic effects may be carried forward to such a degree by thorough annealing treatments, especially at low temperatures, that they will no longer be sufficiently active to produce any appreciable effect within the relatively short time usually allowed in obtaining heating curves.

(4) Activity of the exothermic processes during a reheating or a further annealing at lower temperatures is reduced by increasing the duration of the annealing at any temperature and is usually more completely reduced by annealing at still lower temperatures with the required increases in annealing periods.

(5) Since the exothermic processes tend, in general, to proceed much further at low annealing temperatures and since, at the same time, they meet increased resistance to their activity and consequently become much more sluggish, it follows that the annealing periods must be greatly increased as the annealing temperature of a glass is lowered if the thoroughness of annealing which corresponds to equilibria at these low annealing temperatures is attained.

(6) As this annealing proceeds the activity of the exothermic processes

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since one dependent variable with the temperature is inadequate to determine such a coincidence.)

Likewise, the apparent specific heat, which in the above case is represented by $S/(T'' - T')$, will vary depending on the initial condition, which is seldom one of equilibrium and is always conditioned by the mode of heating or cooling. It follows, therefore, that considerable variation may be expected in the results of tests made within intervals including temperatures in, or near, the annealing range. Although the methods of test ordinarily employed are generally favorable, a true specific heat cannot, in general, be determined except within temperature intervals well below the softening range. If, however, the end temperatures of these intervals are low enough, the rate of heating, or cooling, has no appreciable effect, and the possibility of differences between true and apparent specific heats in such intervals need not be considered. Furthermore, since length of treatment at these temperatures causes no appreciable change in the condition of the glass, repeated tests on the same piece of glass should always give identical results; that is, the results cannot be noticeably changed by varying the treatment preceding the measurements unless the glass was originally very severely chilled or unless the treatments include a heating of the glass to temperatures which rise almost to the annealing range.

usually decreases progressively. It may happen also that those processes which at first showed the greater activity gradually become less prominent in this respect due either to differences in the rates of advance of the various original processes toward that degree of completion required of each for the establishment of equilibrium at the annealing temperature in question or to the appearance and growth in importance of secondary processes.

(7) Heating a glass rapidly to sufficiently high temperatures either before or after equilibrium has been established at a given treating temperature will replace the activity of the exothermic processes by that of the reversed or endothermic processes.

(8) The temperature, at which any one of the more important exothermic processes is reversed, will, in general, not be a characteristic temperature of that process. This temperature will be determined chiefly by the progress which that process has individually made at the treating temperature before the temperature was increased. At any stage of this previous annealing treatment, except that of complete equilibrium, the degrees of progress of the various processes toward establishing equilibrium may be considerably different. Therefore, the reversal temperatures of the several processes may also be correspondingly different.

(9) For simplicity, consider that there is only one process that is affected by annealing and that it is of the type having a variable exothermic to endothermic reversal point. Then, so long as the temperature of the glass is below this point, annealing will progress because the process will be exothermically active. As a consequence, the reversal point will be falling, although at a continually decreasing rate, until it finally coincides with the glass temperature and stops. Further, if the temperature of the glass is rising, "disannealing" will begin, just as soon as the reversal point is passed, because the reversed process will then become endothermically active. In consequence, this point will begin to rise also but the beginning rate will be relatively slow since it is controlled only indirectly by the rate of heating the glass.

(10) This reversal temperature is equivalent to the equilibrium temperature and when once passed it will (on heating as on cooling the glass) generally lag behind the actual temperature (see Fig. 1C).

(11) That is, if the actual temperature of the glass is still rising after the reversal temperature is passed superheating will result because of the sluggishness of the endothermic processes, just as undercooling previously resulted because of a similar sluggishness on the part of the corresponding exothermic process during the cooling; but, as a consequence of the rapidly decreasing sluggishness of the endothermic process as the actual temperature continues to rise, this reversal temperature will soon greatly accelerate its rate of rise and regain much of the lost ground with the result that an abnormal endothermic effect will ultimately be detectable.

(12) If there be only one process, or if the reversal temperatures of the possible several processes are all the same, as they would be in the case of equilibrium, the equilibrium temperature of a specimen of glass may be determined by finding that temperature in the annealing range at which a long heat treatment produces no change in its physical properties; while other similar treatments at temperatures somewhat higher and lower produce changes which, in the density, for example, are ordinary decreases and increases, respectively.

(13) It must be assumed, however, that there is, as previously stated, not one but a number of different processes active in a glass during a heat treatment and that the reversal temperatures of these processes may all be considerably different after any period of treatment such as the usual annealing schedules which are seldom capable of producing an equilibrium. It follows consequently that an equilibrium temperature determined as above described does not necessarily coincide with any of these reversal temperatures although it should always fall at some intermediate position between their extreme values.

(14) While this intermediate temperature is therefore not strictly an equilibrium temperature it may be termed the "effective" annealing temperature of the previous heat treatments since, from the method of its determination, it is evident that these treatments are capable of producing the same value for the property used in the determination as a thorough annealing treatment would normally have produced at this temperature.

(15) Since any given physical property of a glass is presumably more sensitive to the activities of certain processes than to those of others and since this selectiveness probably changes with the property under consideration, it is to be expected that the effective annealing temperatures determined by observations on different properties will differ somewhat.

(16) This possible difference in the reversal temperatures suggests that, in general, glass in proceeding to equilibrium or any other condition passes through a chain of conditions none of which is likely to be that of equilibrium at any temperature, and furthermore, that the number of such possible chains may be very large, although it would appear possible by proper treatments of most glasses in their annealing ranges to make reasonably complete transitions from any one of such chains to any other chain.

(17) Whenever a glass is subjected to a heat treatment at a constant temperature higher than the effective annealing temperature established by the preceding treatments, the endothermic activity of all the reversed processes decreases at a progressively decreasing rate as this new treatment is continued; and, for much the same reasons as in annealing, the processes initially taking a chief part in this activity may be replaced in this respect by others.

(18) As in the case of annealing, the period required for a relatively thorough disannealing decreases rapidly as the treating temperature is raised.

(19) In certain cases (usually in the less stable glasses) certain processes somewhat similar to devitrification may appear which have rather definite and unique reversal temperatures regardless of their degrees of advancement.

(20) In other cases, treatments at certain temperatures may advance certain processes to such a degree that other processes which would be very active during treatments in other temperature ranges are partially or completely suppressed, and this suppression may continue unless it is possible to reverse the suppressing processes or otherwise to reduce their effect by some treatment of the glass.

(21) Such suppressions make it possible to find, below certain temperatures, sets of chains of conditions about two or more apparently independent equilibrium chains which are more or less parallel and which may be connected only by treatments at relatively high temperatures. (All glasses

tend to show such characteristics below the annealing range while the glasses which exhibit them in this range are exceptions to the class considered under section 16.)

(22) The annealing and disannealing under discussion do not take into account the relaxation and introduction of elastic stresses, although these effects may accompany certain of the treatments under consideration.

Because of the changes produced in glass by changing the character of the heat treatment, a comparison of a large number of heating curves obtained on samples that have been prepared by subjecting each of them to one of a properly chosen variety of treatments should show more or less clearly that some of the processes causing the changes are more sluggish than others and that this sluggishness and also the general character of the predominant processes which are active are affected by various conditions among which are the temperature and the effective annealing temperature of the previous treatments of the samples. Such a comparison should also reveal that the reversal temperatures of the several processes active in any one sample are in general different except in the case of glasses which are thoroughly annealed at the chosen annealing temperature, and furthermore, that these reversal temperatures, although they may depend on the general condition of the glass, are determined chiefly by the respective advances which the individual processes had made toward producing equilibrium conditions at low annealing temperatures during the sample's previous treatments, which naturally include a portion of the heating that was required in obtaining the curves.

V. Detailed Exposition of the Curves

Medium Flint Glass

The progressive changes produced in the heating curves as the period of treating at a given temperature is gradually increased are well illustrated by the series of curves shown in Fig. 3. Of these curves No. 1 was obtained on a sample broken from a pot of "medium flint" glass, Bureau of Standards Melt No. 494.[15]

As usual in the case of all glasses taken from pots that are not too quickly cooled, the sample was reasonably well annealed. This is evident from the form of the curve. An exothermic effect is lacking and the endothermic effect is quite pronounced.

Another sample from the same source was broken into small fragments, and these, after being heated at 620°C, were chilled from that temperature by being plunged into cold water.[16] On testing a portion of this chilled sample, curve 2 (the usual form for chilled glasses) was obtained.

[15] An analysis of this glass gave the following composition:

SiO_2	50.55	Na_2O	2.69	Al_2O_3	0.65	CaO	Trace
PbO	40.14	K_2O	5.93	Fe_2O_3	0.02	MgO	Not detected

See also A. Q. Tool and E. E. Hill, *Jour. Soc. Glass Tech.*, **9**, 196 (1925). This glass and also melts 431 and 429 were produced under the direction of A. N. Finn at the Bureau of Standards.

[16] Water was used for quenching since it is convenient and yields more uniform results than other quenchers such as liquid air, mercury, etc. When the particles were not too fine the glass could be quickly and easily dried and showed no visible trace of deterioration due to its contact with the water.

The remainder of the chilled sample was divided into several lots, some of which were heated quickly to 360°C,[17] held there for periods varying from 15 minutes to over 2000 hours, and then cooled rapidly. This temperature was chosen because it is, for this glass, near the lower limit of the range in which an equilibrium can be established without exceeding a reasonable experimental treating period. Curves 3 to 15, inclusive, Figs. 3 and 4, are the results obtained on the samples receiving these treatments.

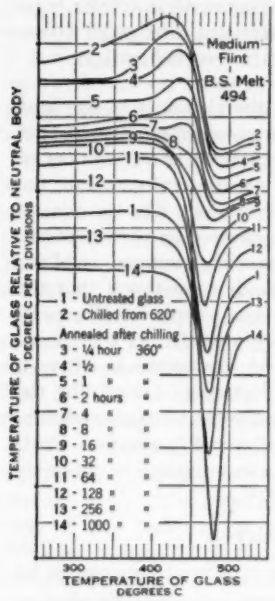
TEMPERATURE OF GLASS RELATIVE TO NEUTRAL BODY
1 DEGREE C PER 2 DIVISIONS
Medium Flint
B.S. Melt 494
1 - Untreated glass
2 - Chilled from 620°
Annealed after chilling
3 - ¼ hour 360°
4 - ½ " "
5 - 1 " "
6 - 2 hours "
7 - 4 " "
8 - 8 " "
9 - 16 " "
10 - 32 " "
11 - 64 " "
12 - 128 " "
13 - 256 " "
14 - 1000 " "
300
400
500
TEMPERATURE OF GLASS
DEGREES C

FIG. 3.—Heating curves obtained on samples of a flint glass where each sample was treated differently as indicated. To make comparison easy the curves have been arranged one above another without reference to zero on the ordinate axis. In practically all cases the width of the lines covers all observed points and observations were made at intervals of approximately 12°, 6°, 3°, or 1.5°C, the shorter intervals being employed between 450°C and 550°C.

This series of curves shows that increasing the period of treatment at 360°C results in producing a more fully annealed glass, since there is correlated with the increasing period a gradual erasure of the exothermic and a concurrent growth of the endothermic effects. It will also be noted from a comparison of curves 1, 12, and 13 that at this temperature a treatment of more than 150 hours is required[18] to obtain the curve form found on the original glass.

After being subjected to a treatment of about the same period at this temperature relatively large pieces of this chilled glass were found to be reasonably well annealed when examined by one of the usual birefringence tests for strain. This shows that such a treatment does not differ greatly in effect from that received by the glass during the initial cooling in the pot.

By such a relatively short treatment, 150 hours at 360°C, the equilibrium condition corresponding to this temperature of the glass was not attained,

[17] The heating temperatures are considered to have been correctly determined to within ±5°C, and the differences between two such temperatures are probably correct to less than that amount. During the long treatments the temperatures seldom fluctuated more than 5°C and then for short intervals only. Naturally, in the 15-minute treatments almost two-thirds of the period was required for the glass to come to the required temperature.

[18] This does not signify that the pot of glass while being cooled was held for such a length of time in the immediate neighborhood of this temperature. As a matter of fact, much shorter periods at somewhat higher temperatures will produce almost the same curve form. Furthermore, a moderate rate of cooling through the annealing range will cause practically the same result.

nor would it have been even closely approached unless the treating period had reached two or three thousand hours. This conclusion is based both on the fact that the endothermic effect could still be increased materially after a thousand-hour treatment and that it was later found that treatments of at least 3000 hours were required at this temperature to secure approximately constant and stable values for the refractivity[19] and density.

In regard to the growth of the endothermic effect with time of holding at this annealing temperature, 360°C, it will be noted from the curves (after the 16-hour treatment which caused the complete disappearance of the exothermic effect (curve 9) and until equilibrium was more closely approached through 256 hours' treatment (curve 13)) that roughly equal increments in the relative cooling of the glass with respect to the neutral body were produced by doubling the treating periods.

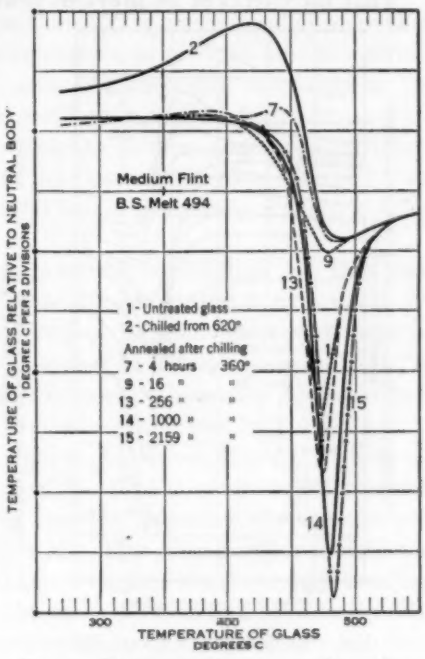

FIG. 4.—Representative curves chosen from Fig. 3 and arranged on the basis of the assumption that all such curves for a given glass should have a common ordinate near the sintering range where it appears that the physicochemical conditions of the respective samples were almost identical.

Representative curves from Fig. 3 are again shown in Fig. 4 where, for the purpose of facilitating comparisons, they have all been made to coincide at approximately 550°C which lies in the range where they flatten out on the second level. This point, or temperature, was chosen because the glass under the experimental conditions involved in obtaining such curves had not yet begun to sinter so far as could be noticed from a cursory examination and also because it appeared that on reaching this temperature the superheating, together with the resultant endothermic effects, had practically ceased.

By discontinuing the heating a little above this point the erratic effects usually accompanying the softening of a glass were avoided, while as previously stated, it seemed safe to assume that a temperature had been

[19] This point was discussed in a paper by Tool, Tilton, and Hill which was read at the Ithaca meeting of the Optical Society of America, October, 1925 (*Jour. Opt. Soc. Amer.*, **12**, 490 (1926)).

reached where the physico-chemical conditions of all the variously treated samples were practically identical. That is, in this temperature range the conditions of the various samples may be considered as being practically independent of all previous heat treatments and as determined almost wholly by the temperatures attained in this final portion of the heating curves.

That the effects of all previous heat treatments were eliminated by the

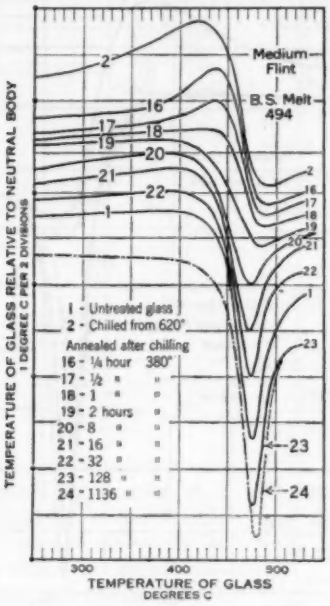
TEMPERATURE OF GLASS RELATIVE TO NEUTRAL BODY
1 DEGREE C PER 2 DIVISIONS
Medium Flint
B.S. Melt 494
1 - Untreated glass
2 - Chilled from 620°
Annealed after chilling
16 - ¼ hour 380°
17 - ½ " "
18 - 1 " "
19 - 2 hours "
20 - 8 " "
21 - 16 " "
22 - 32 " "
23 - 128 " "
24 - 1136 " "
300
400
500
TEMPERATURE OF GLASS
DEGREES C

FIG. 5.—Heating curves obtained on samples of the same flint glass yielding the curves in Fig. 3 but with the difference that the special annealing treatments were given at 380 °C instead of 360 °C.

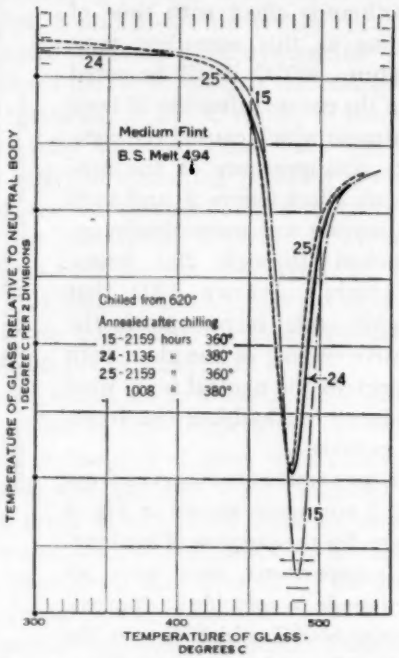

FIG. 6.—A comparison of the results of approximately thorough annealing treatments received by the chilled flint glass at 360 °C and 380 °C.

required heating to these temperatures and that the conditions of all the samples on reaching the chosen reference temperature employed in these diagrams were practically identical was proved by retesting several of the samples after they were all cooled according to a common schedule from the maximum temperature reached in obtaining the data for this curve series. In every case the retest curves were identical in form; it was found that this form was entirely determined by the incidental annealing imposed on the samples by the cooling after the maximum temperature of the first tests was reached.

In obtaining data showing the effect of changing the treating temperature additional lots of the chilled sample were heated rapidly to 380°C in-

stead of 360°C, held there for periods ranging from 15 minutes to over 1000 hours, and then cooled very rapidly as before. Together with Nos. 1 and 2, the heating curves, Nos. 16 to 24, obtained on these lots of glass are shown in Fig. 5.

This series of curves shows many of the same characteristics in the disappearance of the exothermic and in the growth of the endothermic effect as those found in the series of Fig. 3. The changes, however, proceeded more rapidly at 380 than at 360°C and less than 100 hours (instead of more than 150) were required at the higher temperature to produce an endothermic effect of the magnitude found in curve 1. The small increment in the relative cooling of the glass with respect to the neutral body, shown by a comparison of curves 23 and 24 in which the holding periods differed by a factor of approximately 9, shows that the glass used to obtain curve 24 had (after the treatment of more than 1100 hours) practically reached equilibrium at 380°C.

That curve 24 corresponds to a practical equilibrium for this glass when treated at 380°C is also indicated by comparing it with curve 25, Fig. 6, which was obtained after re-treating, for more than 1000 hours at 380°C, a part of the lot which was sampled in obtaining curve 15. The previous treatment had caused this lot of glass to approach equilibrium at 360°C and, consequently, the relative cooling indicated by curve 15 is, as should be expected, greater than that shown by curves 24 and 25, which the comparison shows to be almost identical.[20] That is, after the treatment at 380°C, the relative cooling shown by curve 25 is, within the experimental error, the same as that shown by curve 24. This procedure for establishing the maximum endothermic effect, which corresponds to the equilibrium condition at any temperature, can also be carried out over other temperature intervals and it demonstrates the reversibility of the processes involved. Experiments have shown, however, that other characteristics of glass can be used with much greater facility in determining accurately[21] whether a

[20] In a paper previously cited (*Jour. Opt. Soc. Amer.*, **8**, 433 (1924)), it was shown that decreasing the temperature of equilibrium of a glass increased the relative cooling shown by the heating curves, and that all samples of the same glass brought to equilibrium at the same temperature should give identical relative coolings.

[21] This was demonstrated on the same glass by curves shown at the Ithaca meeting of the Optical Society (see footnote 19), giving its change in refractivity with treating temperature. Lebedeff also (*Glas-Ind.*, **35**, 6, January (1927)) obtained similar results but on a different glass and in a temperature range where the mobility was much higher. His curves in form and presentation are almost identical with those shown at the meeting mentioned and point to this same advantage of accuracy. See also A. I. Stozarov, "The Variation of Refractive Index of Glasses at High Temperatures," *Trans. Opt. Inst. Leningrad*, **4** [39], 1–36 (1928). Since the completion of this paper an article by E. Berger (*Glastech. Ber.*, **8**, 359 (1930)) has appeared which to some extent discusses Stozarov's results and many of the views expressed in it are in full accord with those presented here.

glass has reached equilibrium at any given temperature; consequently this method is not recommended for other than special tests.

Borosilicate Crown Glass

In Figs. 7, 8, and 9, additional series of similar curves are given which were obtained on a borosilicate crown glass. Bureau of Standard Melt No. 431.[22]

The samples furnishing these curves were prepared in the manner described above, except that the glass in this case was chilled from 750°C and then re-treated or annealed at either 450°C or 475°C as indicated.

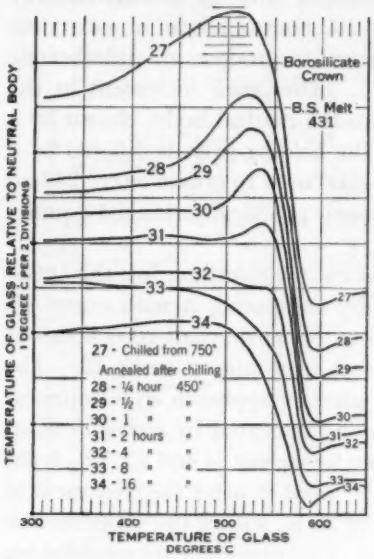

FIG. 7.—Similar heating curves arranged as in Fig. 3 but obtained on samples of a borosilicate crown, each sample being differently treated as indicated. In consideration of the low annealing temperature (450°C) the annealing periods are all relatively short and failed to erase completely the effect of the previous chilling from 750°C.

Curve 26 was obtained on glass taken directly from the pot, while curve 27 (see Figs. 7 and 8) shows the result on this glass after the chilling.

The series in Fig. 7 gives another exhibition of the gradual disappearance of the exothermic effect as the period of treatment is increased, while that in Fig. 8 again makes apparent the large increase produced in the endothermic effect by lengthening the treating period.

In the case of both series (Figs. 7 and 8) the treating temperature was 450°C, which is near the lower limit of the range where equilibrium can be reached in a practicable time. Here it appears that approximately 250 hours are required to produce a relative cooling equal to that found on the original glass (see footnote 18).

From a comparison of curves 37 and 38, it will be noted also that a treatment of somewhat more than 4500 hours seems to have produced a condition of practical equilibrium at this temperature; however, a further slight increase would undoubtedly have been obtained if the period had been very greatly increased.

In obtaining curves 39 and 40, the method discussed above in describing curves 24 and 25 (Fig. 6) was used to determine whether equilibrium had

[22] Analysis of this glass shows the following composition:

SiO_2	64.52	K_2O	10.84	BaO	2.56	R_2O_3	0.35
B_2O_3	11.93	Na_2O	7.85	ZnO	2.66		

See article by Tool and Eichlin, *Jour. Opt. Soc. Amer.*, **8**, 421 (1924).

been established in the samples treated at 475°C. Thus curve 39 was obtained on a second sample taken from the lot that had been treated over 4500 hours at 450°C and had then furnished the sample yielding curve 38.[23] Before yielding curve 39 this second sample was given an added treatment of more than 1000 hours at 475°C.

On comparing curve 39 with curve 40 which was obtained on a sample

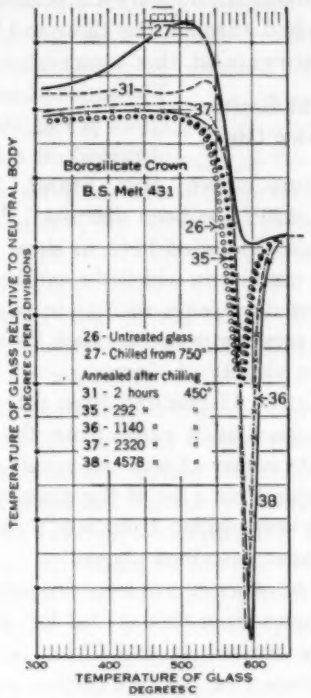

FIG. 8.—Selected heating curves for the same borosilicate crown showing the effectiveness of much longer annealing periods at 450°C in removing the effect of chilling from 750°C.

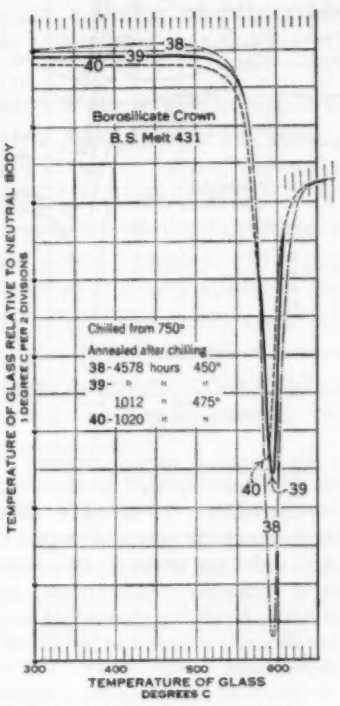

FIG. 9.—A comparison of the results of relatively thorough annealing treatments received by the chilled borosilicate crown at 450°C and 475°C.

that was taken from the unannealed chilled glass and then also treated over 1000 hours at 475°C, it will be seen that the endothermic effects of the two curves are practically the same although that of the former is some-

[23] In this connection it should be mentioned that the magnitudes of the extreme dips of curves 38 and 39 below the first and second levels are not inconsistent with the conclusions drawn from the results given in Table I, p. 430, and Fig. 4, p. 433, of a previous paper (*Jour. Opt. Soc. Amer.*, Vol. 8 (1924)). These conclusions concerned the increasing depth of such dips as the equilibrium temperature was decreased.

what larger, as should be expected. From this it may be inferred, as stated above, that both samples were in practical equilibrium at 475°C when the treatments ended. This inference follows since for one sample the relative cooling caused by the endothermic effect increased while for the other it decreased toward a common limit which it appears was practically reached through the thousand-hour treatments at this temperature.

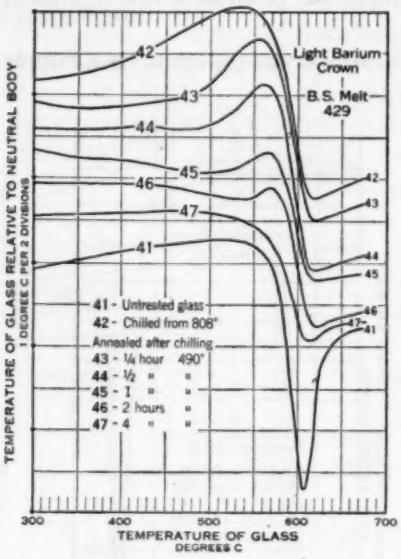

FIG. 10.—Heating curves obtained on samples (differently treated as indicated) of a barium crown. These curves show that the forms of the curves presented in Figs. 3, 5, and 7 and obtained after short periods of annealing chilled samples are typical results for chilled glasses that have been insufficiently annealed at low annealing temperatures.

Light Barium Crown Glass

The series of curves given in Fig. 10 and obtained on a light barium crown, Bur. Stand. Melt No. 429[24] has been discussed,[25] but is also included here to show that the manner in which the exothermic effect disappears with an increase in the treating period is much the same for a variety of glasses.

Curve 41 resulted from a test on the glass as it came from the pot, while curve 42 was the result on a sample from a lot of the glass which had been chilled from 808°C in the manner described above.

The other curves were procured on samples from this chilled lot which were treated at 490°C for periods indicated in the descriptive legend of the figure.

The results obtained after longer periods of treatment are not included, but they were quite similar to those shown for the other glasses.

Those curves in Figs. 3, 5, 7, and 10, that were obtained on glasses which were in the intermediate conditions that must be passed through as the activity of the various processes and reactions advances a glass toward equilibrium and before the last trace of the exothermic effect disappears, all show certain peculiar transitional changes in curve form which corre-

[24] The composition of melt 429 is approximately

SiO_2	47.8	BaO	27.1	MgO	0.2	K_2O	7.6
B_2O_3	4.3	CaO	2.5	ZnO	8.2	Na_2O	2.1
R_2O_3	0.2						

[25] "Some Thermal Effects Observed in Chilled Glass," Tool and Eichlin, Rochester, N. Y., October 24–26, 1921.

spond to certain differences in such intermediate conditions. Thus, on considering the region below the treating temperatures, it is seen that a 15-minute treatment reduced the first level of the curves to its normal height for an annealed glass and thereby eliminated in this temperature range practically all trace of an exothermic effect although it produced only a relatively small reduction in that effect at higher temperatures. As the length of treatment increased, the exothermic effect at these higher temperatures was gradually reduced although a vestige of it may often be detected in curves obtained on samples which have received a treatment for many hours.

Whenever tests of this nature are carried out it will be found that in almost every case some of the moderately short treatments, especially if they are given at low temperatures, result in curves having the form shown by curve 7, Fig. 3, where a slight but characteristic depression occurs in the curve in the temperature range corresponding to the beginning of the normal endothermic effect of a glass that is well annealed. This probably signifies that certain exothermic processes were practically completed by these moderately short treatments to the extent required for equilibrium at the low annealing temperature but that they were reversed as soon as the glass was heated to higher temperatures and became endothermically active before the reversal temperatures of certain other more sluggish but still exothermically potent processes had been reached.[26]

A study of these curves also suggests that at times an exothermic process, whose reversal temperature is found to be near that of the previous treatment, may easily be more active in that range than one whose reversal temperature after the same previous treatment is much higher but whose activity might have been the greater and more potent of the two if the preceding treating temperature had been higher. Whenever there is any marked interference between such processes this change in relative activity with temperature makes it possible through a proper manipulation of treatments and cooling rates to aid either process in suppressing or hindering the other.

Fused Germanium Dioxide

Some results on two other types of glass are presented in Fig. 11. Of the fused germanium dioxide prepared in the laboratories of Cornell University only a limited sample was available for test. Expansivity measurements

[26] A certain amount of evidence has been found showing that some of these exothermic processes in incompletely annealed glasses do not reach their maximum activity until temperatures near the upper limit of the usual endothermic effect are reached. In the case of the borosilicate investigated this would be in the neighborhood of 600 °C. Such evidence is, however, difficult to obtain since all exothermic effects in this range are masked by the greater endothermic effects arising from processes having lower reversal temperatures.

made on this glass by G. E. Merritt indicated that it was unannealed, yet it will be noted that the exothermic effect shown by curve 48 for the untreated glass is small. Likewise the endothermic effect in curve 49 obtained after annealing the glass was not large, although it might possibly have been increased by choosing a more favorable heat treatment. As usual the annealing treatment did not greatly change the difference between the first and second levels. This difference is, however, smaller than that ordinarily observed with other glasses so far tested. The relative smallness of the exothermic and endothermic effects before and after annealing, respectively, and of this difference between levels as compared with the corresponding effects in most other glasses may possibly be ascribable both to a smaller tendency toward intra-molecular changes in this glass and to a greater sluggishness on the part of its processes.

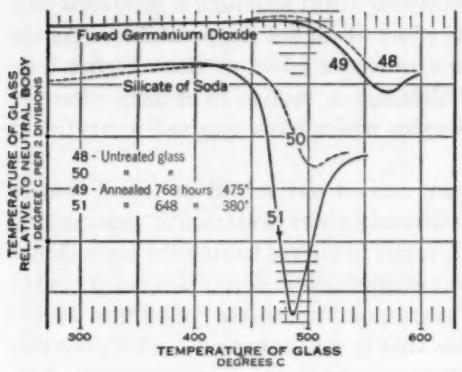

FIG. 11.—Heating curves of two glasses, one of which is rare and was produced for experimental purposes only while the other although produced commercially is naturally not employed for the usual purposes of a glass.

Silicate of Soda Glass

The silicate of soda glass was a soluble commercial product of undetermined composition. Curve 50 was taken on some of the original or untreated glass, while curve 51 is the result obtained on a sample after it had been treated over 600 hours at 380°C. It is evident from these curves that this treatment greatly increased the endothermic effect. In fact, so far as has been observed, this effect is always increased when any imperfectly annealed glass is re-annealed in the range immediately below the temperature where the effect normally begins.

VI. General Discussion and Conclusions

(1) From the data and discussion presented it is evident that the conclusions reached in the previous papers cited concerning the possibility of establishing equilibrium conditions in glass are well supported.

(2) With a given glass these conditions vary with the temperature and form a continuous chain of equilibrium conditions, which generally extends throughout the practical annealing range and often to both higher and lower temperatures.

(3) When a glass is treated at a chosen temperature the equilibrium for that temperature is approached at a constantly decreasing rate as the treatment is continued; that is, the reaction rates of the effective processes decrease exponentially as the treating time increases and the initial rate is cor-

respondingly greater when the initial condition is farther removed from the equilibrium condition approached.

(4) These reaction rates may also depend somewhat on the direction from which equilibrium is approached, that is, the initial rate of approaching equilibrium may depend on whether the difference between the effective annealing temperature of the initial condition and the treating temperature is positive or negative, although the absolute magnitudes of these differences as measured by the changes in some characteristic of the glass may be equal.

(5) Moreover, in the temperature ranges covered by these investigations and also by those on refractivity and density, both the velocity of these reactions, when the initial conditions so far as can be determined are about equally removed from equilibria, and the mobility of the glass appear to vary with the treating temperature in a manner which follows more or less closely the empirical rule derived from such compilations of data as that of van't Hoff[27] on the change of reaction velocity with temperature.

(6) In general, both the stable condition toward which a glass of given composition[28] is advancing during treatment and the velocity of this reaction should be determined both by the treating temperature and by the previous thermal history. So long as this history is limited to treatments that are confined to the annealing range or still lower temperatures most of the glasses so far tested do not show any marked effects of the previous history[29] which interfere with an almost perfect reversibility at all temperatures within the annealing range.

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[27] van't Hoff, Chemische Dynamik, p. 225 (1898), ref. from Nernst's Theoretical Chemistry; Chemical Dynamics, p. 125 (1896) (translation by Ewan).

[28] In this connection the effect of ever-present impurities, dissolved gases, etc., cannot be entirely neglected, but as so little is known in general concerning their action, an attempt at this time to analyze any possible relation they may have to the heat effects and the various changes caused by different heat treatments appears to be useless.

[29] It is evident from the foregoing discussion that any glass in common use cannot be reduced to equilibria corresponding to ordinary or atmospheric conditions; and even at relatively high temperatures there is, with some glasses at least, a question concerning whether the condition actually developed is the ultimate condition of stability that would have been reached if the resistance met at various periods during the cooling from the molten state had not grown too great to allow a sufficiently rapid readjustment. This question remains even though a certain reversibility is later obtained when the temperature of treatment is raised and lowered repeatedly through various cycles in the annealing range. If the failure to reach a condition of ultimate stability can result from the previous heat history at relatively high temperatures as well as the temperatures in the annealing range, it may well happen in some cases that varying the number, length, and type of treatments in certain ranges (the molding range, for example) may bring such a condition considerably nearer and materially change the apparent equilibrium series of conditions at other, and especially at lower, temperatures.

This effect of previous history at high temperatures leads to the possibility of more than one equilibrium series throughout the annealing range of a glass as well as in the still lower ranges previously mentioned. In part, this possibility is the basis for the feeling sometimes expressed that changes in the method of processing glass at high temperatures produce permanent differences in its properties without altering the

(7) Some glasses, *e.g.*, some of the Pyrex group,[30] are exceptional in this respect since treatments in certain parts of the annealing range seem to induce conditions in these glasses which lead to different equilibrium chains or sequences at lower temperatures in that range.

(8) These conditions developed in the annealing range are apparently induced by the excessive advancement of certain processes which cause an almost complete suppression of other processes. This condition would lead to a different equilibrium sequence which may or may not be nearer that sequence followed when the cooling is extremely slow.

(9) Reversing the suppressing processes by heating the glass to higher temperatures (near or somewhat above the annealing range) usually restores it again to conditions which are in the slow cooling sequence and are also common to the other equilibrium sequences involved.

(10) While the glass in many cases may be carried through an indefinite number of cycles about each of these sequences there is at times some indication of a very slight drift from some of these possible sequences toward certain others which are usually those nearer the slow cooling sequence. This would seem to indicate that there is often a varying degree of approximate stability in these sequences and that the suppression of those processes whose lack of advancement caused the glass to enter the less stable sequence was not complete.

(11) It may well be that the chief difference between glasses showing this effect and the apparently more common types which do not is chiefly a matter of the detectability of the effect and of the temperature range in which it occurs. That is, all glasses at temperatures below the annealing range may be made to follow a large number of different sequences about which it is possible to carry them through apparently closed cycles of conditions; but it may well be that these sequences constitute a series of only quasi-stable conditions and that if the cycles about them are repeated a sufficiently large number of times a drift could be detected toward the sequence of equilibrium conditions which apparently can only be reached by a cooling treatment that would be so extremely slow that it would be impractical, if not impossible.[31]

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composition; and it is a very good reason for experiments such as those of Eckert (*Z. tech. Phys.*, p. 282 (1924)). It has been found, however, as his results also indicate, that irreversible effects of previous history at molding temperatures are probably small since preheating most glasses to relatively high temperatures before re-annealing will usually erase such differences in properties as may have been observed in a glass at lower temperatures, unless the causes of such differences were originally produced at temperatures well above the annealing range (*e.g.*, by long treatments in the molding range or at even higher temperatures). In such cases the causes may have constituted a change in composition, something having the nature of a devitrification, or possibly a greater degree of segregation of the components as their mutual solubility decreased at temperatures below the melting range. Increasing devitrification caused by prolonged treatments at high temperatures will cause a gradual shift of the range in which the endothermic effect observed in heating curves is obtained.

[30] A. Q. Tool and E. E. Hill, *Jour. Soc. Glass Tech.*, **9**, 196 (1925). A. Q. Tool, E. L. Peffer, and J. B. Saunders, Annual Meeting, AMERICAN CERAMIC SOCIETY, Toronto, Ont., February, 1930.

[31] In annealing ordinary glassware it is not economically feasible to establish a fully stable condition at any point in the annealing range except possibly at the highest

(12) The two glasses (Bureau of Standard Melts 431 and 494) which yielded the greater part of the data given in this article and, with a number of others, have been thoroughly investigated with regard to the refractivity and density changes[32] which are possible as a result of treatments in the annealing range,[33] each gave evidence of only a single equilibrium sequence

temperatures and from these cooling cannot be accomplished rapidly without the introduction of strain unless the articles are small. Since economy requires the shortest annealing procedure possible, the chief object so far as the physico-chemical condition is concerned must be the obtaining of a reasonable uniformity in this condition throughout the piece of ware and the maintaining of this uniformity until comparatively low temperatures are reached where there is no danger that it will be disturbed materially. If the glass be heated to temperatures just below those where undesired deformations are to be feared, such a uniformity of condition within the glass is usually established very quickly if the temperature distribution in the ware is uniform. Furthermore, this uniformity of condition will generally be maintained to a sufficient degree throughout any cooling procedure that does not introduce undesirable strain. The physico-chemical condition resulting from such a treatment will usually correspond, at least roughly, though not exactly, to one of equilibrium at some temperature which can be determined approximately (see paragraph 14, part IV). If this temperature is fairly low in the annealing range, the changes in the condition of the glass will neither be noticeable over reasonably long periods nor markedly different in the various parts of the piece so long as it is always used at considerably lower temperatures and is not subjected to large and long-continued temperature differences between its parts.

This ordinary annealing is, however, not adequate for glass intended for precision apparatus even when there is no strain of an undesirable magnitude present. For example, it was shown in the paper cited in footnote 19 that a gradient of one degree per meter within the annealing furnace, while it is being held at the annealing temperature, might easily cause such a lack of physico-chemical homogeneity that variations of several units in the sixth decimal of the refractivity would result even within pieces of glass whose major dimension was not more than 10 centimeters.

[32] A. Q. Tool and E. E. Hill, *Jour. Soc. Glass Tech.*, **9**, 196 (1925). Annual Reports of the Director of the Bureau of Standards, U. S. Dept. of Commerce, pp. 11, 23, 21, and 25 of years 1925, 1927, 1928, and 1929, respectively.

[33] Since glass is employed chiefly at ordinary temperatures, data which are obtained on its refractivity and density under such conditions and which are serviceable in determining the effective annealing temperatures are more important from a practical standpoint than those obtained on the same properties at temperatures where the glass is being treated for the establishment of equilibrium conditions. Theoretically, however, it is also very important that data on these properties should be determined not only at a standard temperature in the range where glass is ordinarily used, but also at several temperatures in the range where equilibria can be attained. In fact, this should be done in every range where appreciable changes of any sort from heat treatment are likely. Only in this way can the relations between the properties of glass at different temperatures and in different conditions of equilibrium be satisfactorily determined, and the effects of annealing, or cooling at different rates, and of other variations in the treatments be fully evaluated.

Early in the progress of these investigations consideration was given to an interference method whereby the rate of approaching equilibrium could be studied and whereby other tests regarding this condition could be made through data simultaneously obtained on both the density and the refractivity changes which occur while the annealing, cooling, and heating treatments are being accomplished. So far, however, very

in this range although at lower temperatures there was the usual multiplicity of such sequences,[34] about which cyclic chains of "intermediate"[35] conditions may be established by suitable heat treatments at different points in a series of temperature cycles.

(13) This tendency of glass to follow sequences of quasi-stability at relatively low temperatures is presumably due to the persistence of certain reversible processes after many of the important ones in the annealing ranges have been suppressed. Among the important processes which persist are those responsible for the true expansivities and contractivities as well as those which produce the modifications which result in the corresponding apparent coefficients.

(14) Without taking into account the possible effects of the previous history of a glass at temperatures above the annealing range and considering only the great number of unstable sequences which it may be made to follow in the annealing range and which apparently become equilibrium series of conditions at still lower temperatures where they may be made to branch into a still greater number of such sequences because of certain unsuppressed processes, it will be seen that the apparently stable conditions in which a glass may be procured at room temperatures is unlimited and that any of its properties can be made to assume values anywhere within ranges of considerable breadth.

(15) The density and refractivity, for example, can be varied about 1%, and roughly one-half of this may be procured by varying the treatments in the lower part of the annealing range, which is that portion of the range utilizable for optical glass.

(16) The various effects mentioned in the papers are also found in simple glasses, *i.e.*, those comprising only one oxide,[36] such as

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little progress has been made on this project; and since such a method becomes tedious when the changes progress as slowly as they do at the lower temperatures of the annealing range, which from the standpoint of optical glasses are the most important, it was decided to use for that range of treating temperatures the less comprehensive method described in a previously mentioned paper (see footnote 19). That the interference method could be used to advantage in the upper annealing range is shown by Lebedeff's (footnote 21) data (obtained by another method) on the refractivity changes occurring during treatment.

[34] A. Q. Tool, D. B. Lloyd, and G. E. Merritt, Bur. Stand., *Jour. Research*, **5**, 627 (1930); *Jour. Amer. Ceram. Soc.*, **13** [9], 632 (1930).

[35] The term "intermediate condition" refers to one which arises, for example, during the transition from a condition of equilibrium at one temperature to that at another, but which may not be one of equilibrium at any temperature (see footnote 14). The possibility that such conditions are produced in glass has been mentioned previously (see article by A. Q. Tool and E. E. Hill, *Jour. Soc. Glass Tech.*, **9**, 190 (1925)) and it should be added that analogous conditions may arise even in very fluid solutions when the temperature is varied rapidly.

[36] It is possible that there may be several components in a glass with only one constituent oxide and that the equilibrium between these possible components may vary with the temperature. The processes involved in producing such an equilibrium condition might account for the thermal effects noted in the simple glasses mentioned as well as in the more complex. To some, these different components may appear to be caused by varying degrees of polymerization and the formation of complex molecules from groups of simple units as predicated by different theories (for example, see theory

B_2O_3,[37] SiO_2, or GeO_2, as well as in the more complex.[38]

(17) This degree of possible variation emphasizes the need for great care in duplicating exactly the annealing conditions whenever it is necessary to produce a high degree of uniformity[39] in any property of a large piece or a large number of pieces of a glass.

(18) It also suggests the use of variations in the annealing schedule for the purposes of compensating for small differences in certain properties where such differences result because of slight accidental variations between the compositions of different melts.

(19) Furthermore, it shows the caution which must be exercised whenever it is desired to determine the effect a change in certain constituents of a glass will have on any property such as density or refractivity. This follows since any change in composition also changes the annealing characteristics of a glass and usually makes it inadvisable to follow the same annealing schedule for all samples while at the same time there are no adequate clues as to what would be the equivalent schedules in the various cases.

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of Asch and Asch, "The Silicates in Chemistry and Commerce," translation by Searle, Constable & Co., London, 1913). Others may see a similarity between these effects in glass and the development of the more orderly molecular arrangements which have apparently been detected by means of X-ray studies of different liquids as they approach their congealing temperatures. It may also seem that the processes contemplated in both views may either be independent or related in their possible responsibility for the changes observed in glass but in view of the data available at present it would appear inadvisable to speculate too deeply concerning the nature of the processes involved in the various unknown molecular rearrangements which probably occur.

[37] In view of the probable density changes coincident with changes in rate of cooling a B_2O_3 glass (in regard to the heat absorption effect in this glass see Tool and Valasek, Bur. Stand., *Sci. Papers*, No. 358 (1920)) it would appear unsafe to base conclusions concerning the relative atomic weights of boron in different samples on density measurements made on this glass, as Briscoe, Robinson, and Stephenson (*Jour. Chem. Soc.* [London], Part 1, p. 70 (1926)) appear to have done, unless great care is taken to cool the whole set of samples required in any one comparative test according to the same schedule.

[38] It would appear that similar effects should be found in glasses containing no silica or any of the other necessary acidic constituents common to ordinary commercial inorganic glasses. This leads to the assumption that they are probably present in all vitreous organic materials as well. Such a view is supported by the results of M. O. Samsoen, "Contribution à L'étude de L'état Vitreux et de la Dilatation des Verres" (1927) and also of G. S. Parks and various collaborators:

Gibson, Parks, and Latimer, *Jour. Amer. Chem. Soc.*, **42,** 1547 (1920).
Gibson and Giangue, *ibid.*, **45,** 93 (1923).
Parks, *ibid.*, **47,** 341 (1925).
Parks and Huffman, *Science*, **64,** 364 (1926).
Parks and Huffman, *Jour. Phys. Chem.*, **31,** 1842 (1927).
Parks, Huffman, and Cattoir, *ibid.*, **32,** 1368 (1928).
Cattoir and Parks, *ibid.*, **33,** 879 (1929).
Parks and Gilkey, *ibid.*, **33,** 1428 (1929).

In these articles many other important references are noted which bear directly on the nature of the vitreous state.

[39] L. W. Tilton, A. N. Finn, and A. Q. Tool, Bur. Stand., *Sci. Paper*, **22** (No. 570), p. 719 (1928); *Jour. Amer. Ceram. Soc.*, **11** [5], 292 (1928).

Explanation of Fig. 1

In part *A* of this figure, curve *A* is intended to represent roughly the course of the temperature of a sample of glass at all times during a relatively thorough annealing schedule in which the annealing temperature is chosen quite low in the practical annealing range. Curve *B* represents the course of the temperatures at which the glass would be found to be in equilibrium at various times. That is, if the temperature of the glass were at any time during the annealing raised quickly from curve *A* to *B* no further changes of a marked degree would be noted in the refractivity, density, etc., so long as the temperature remained constant.

Curves *A'* and *B'* in part *B* have a corresponding significance in a case where a glass sample is supposed to cool very rapidly.

In part *C*, curve *A''* represents the course of the temperature of either of these samples if they are heated at a normal rate for heating curve tests. Curves *B* and *B'* show the corresponding changes in the equilibrium temperatures of the two samples. Curves *C* and *C'* would represent the respective corresponding changes if the heating rate had been lower; while *D* and *D'* represent the same for an increased rate. For both the slower and faster rates it is evident that (as the curves are plotted) the abscissas must be multiplied by appropriate factors. It will also be evident that the magnitude and definiteness of the exothermic effects observed in the heating curves obtained on the chilled glass (curve 2, Fig. 3 is an example) will depend primarily on the extent to which *B'*, *C'*, and *D'* drop below the original level of *B'*, the quantity of heat thereby liberated, and the heat capacity of the test sample, although the sample's insulation is also a factor. The magnitude and definiteness of the endothermic effects in the heating curves of both the chilled and annealed samples (curves 2 and 14, Fig. 3) will be controlled mainly by the lags of curves *B'*, *C'*, *D'*, *B*, *C*, and *D* below the curve *A''* after crossing it. They will also be affected by the rapidity with which these curves regain their losses at higher temperatures and the quantity of heat absorbed per degree rise in the equilibrium temperature. The heat capacity and insulation of the samples as in the case of the exothermic effects are additional factors.

COMPARISON OF BODIES CONTAINING BLENDED FELDSPARS AND ONE-MINE FELDSPAR OF SIMILAR COMPOSITION[1]

By C. W. Parmelee and C. R. Amberg

ABSTRACT

An electrical porcelain body mixture was prepared in several batches, each of which contained a different feldspar. These several bodies were formed by hand pressing, extrusion, and casting. After they had been fired a comparison was made of the volume changes and bulk specific gravities.

I. Introduction[2]

Since the introduction of blending or chemical control of feldspar there has been much discussion of the effects of this practice on the resulting material. There is no doubt but that chemical control was a great step forward in creating uniformity in feldspars but there are still instances which seem to show that blending of one pair of feldspars to produce a certain composition may not produce the same physical properties in the mixture that will be caused by the blending of another pair of feldspars.

Considerations of the mode of occurrence and the nature of feldspars are of prime importance in understanding the possibilities and defects of blending. In commercial feldspars the prime constituents are microcline (potash feldspar), albite (soda feldspar), and anorthite (lime feldspar). The lime and soda feldspars invariably occur in the same crystal in solid solution known as plagioclase. They never separate into individual crystals. Therefore all the lime and soda of a feldspar will be found in the plagioclase crystals.

If the cooling of the magma has been infinitely slow, as in the case of pegmatites, the plagioclase will be of the same soda-lime ratio rather than in zones of different composition as it would in the case of rapid cooling without opportunity for diffusion. The microcline and plagioclase in commercial feldspars, however, occur in separate crystals.

Alling[3] has shown how solid solution occurs between potash and soda feldspars but if the melt has been cooled slowly enough the two dissociate, forming microscopic crystals of soda feldspar and potash feldspar intergrown. This is called microperthite. Under other conditions they may segregate into relatively large-sized crystals of each. Thus in any peg-

[1] Presented at the Annual Meeting, American Ceramic Society, Toronto, Ont., February, 1930 (White Wares Division). Received December 4, 1930.

[2] The results presented in this paper are from an investigation conducted by the Engineering Experiment Station, University of Illinois, Department of Ceramic Engineering and in coöperation with the Consolidated Feldspar Corporation. The full report of the investigation will appear in a bulletin of the Engineering Experiment Station.

[3] H. L. Alling, "The Mineralography of Feldspars," *Jour. Geol.*, p. 290, April-May (1921).

matite deposit lumps of almost pure potash feldspar and lumps of almost pure soda feldspar or plagioclase will be found.

In the lumps of microcline there will be some microscopic crystals of plagioclase and likewise some microscopic microcline in the lumps of plagioclase. When finely ground, however, these microscopic crystals are broken apart and the ground feldspar consists of tiny crystals or fragments of microcline and plagioclase. Anyone can verify this with a petrographic microscope and a few index oils. The separation is so complete that Insley[4] has devised a method of grain-counting by which a quantitative analysis in terms of microcline and plagioclase can be obtained.

As it chances, in the sorting of feldspar at the mine in order to remove such iron-bearing impurities as garnet, mica, tourmaline, etc., at one time there may be a preponderance of large lumps of plagioclase and at another, microcline. It is difficult to judge by the eye which is which. In this case the crushed material of two batches may be analyzed and the two mixed in such proportions as to produce the desired potash-soda ratio. When ground there will be a mixture of microcline and plagioclase fragments, but the plagioclase will all be of the same soda-lime ratio. If, however, the product of different mines is used, the plagioclase particles may be of different soda-lime ratio and hence alter the properties of the mixture. Whether or not this is of sufficient importance to warrant special attention is the problem inciting the work here reported.

II. Firing Behavior of Feldspars

In the course of some work on the thermal expansion of fused feldspars it was noted that, as the porosity of the material decreased with treatment at higher temperatures, the thermal expansion increased and that at still higher temperatures when vesicular structure developed, the expansion decreased. Accurate measurements of the thermal expansion of a

No.	4	8	7	2
Name	English knob	50% Crabtree 50% Fannie gouge	Crabtree	Fannie gouge
P. C. E.	8	7	7.5	6.5
K_2O/Na_2O Orthoclase Plagioclase	1.71	1.73	1.84	0.94
Analysis:				
Ignition loss	0.26	0.38	0.23	0.29
SiO_2	70.72	69.52	69.74	68.28
Al_2O_3	17.71	17.82	17.04	18.52
Fe_2O_3	0.086	0.083	0.08	0.096
CaO	0.18	0.48	0.28	0.79
MgO	0.11	Trace	Trace	Trace
Na_2O	3.31	3.38	3.29	4.10
K_2O	8.32	8.70	9.09	7.81
Na_2O/CaO	18.4	7.0	11.7	5.2

[4] Herbert Insley, "Quantitative Microscopic Analyses of Commercial Feldspar," *Jour. Amer. Ceram. Soc.*, **10** [9], 65 (1927).

feldspar fused at various temperatures may thus be used to give an indication of its firing range. The preceding feldspars showed a peculiar behavior which can only be attributed to blending.

Number 4 and No. 8 are similar but No. 4 is a one-mine feldspar and No. 8 is blended from the product of two different mines. The first thing noted is that, despite the similarity of composition, No. 8 has a P.C.E. one cone lower than No. 4. Figure 1 shows the firing behavior of these feldspars.

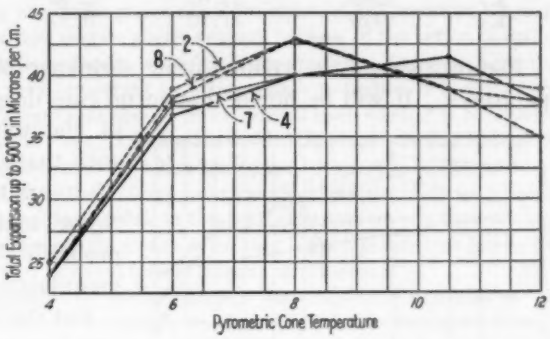

FIG. 1.

Number 4 matures gradually until cone $10^1/_2$ and then begins to overfire. Number 7 behaves somewhat similarly. Number 2 matures rapidly until cone 8 and then overfires. Number 8, the blend of Nos. 7 and 2, behaves much like No. 2, not at all like No. 7, and entirely unlike No. 4 which it resembles in composition.

III. Variation Due to Feldspar in Porcelain

To investigate further the behavior of mixed and one-mine feldspars, a series of porcelain bodies of the following composition were made:

H & G A1 English china clay	30
Special Kentucky ball clay	20
Feldspar	30
Flint	20

The following feldspars were substituted in this body, adjustments being made to allow for the free quartz and kaolin of the normative analysis:

	No. 6 McKinney	No. *x* 87.8% straight branch 12.2% No. 45 glaze	No. 7 Crabtree	No. *y* 89.6% straight branch 10.4% No. 45 glaze
Quartz	7.4	9.58	14.45	9.46
Microcline	56.1	57.05	53.78	58.01
Plagioclase	31.9	32.36	29.29	31.56
Kaolin	4.9	1.33	1.65	1.31
Al_2O_3			0.61	
H_2O				
Total	100.3	100.32	99.78	100.34
Microcline-plagioclase	1.76	1.76	1.84	1.84

The bodies were blunged, lawned through a 120-mesh screen, dried in cloth-lined plaster bats, thoroughly wedged, and made into bars for the determination of modulus of rupture and shrinkage.

The results secured are shown below:

Body	Modulus of rupture (cone 12)	Volume firing shrinkage (cone 7)	(cone 9)	(cone 12)	(cone 13)
K6	9700	31.86	31.53	31.04	30.87
K*x*	9160	31.98	32.47	31.68	29.91
K7	9260	32.63	32.81	31.52	30.35
K*y*	9410	31.70	31.77	31.60	30.74

Figure 2 shows the volume firing shrinkage plotted against cone temperatures. It will be noted that in no case does the shrinkage behavior of the mixed feldspar correspond with that of the one-mine feldspar. The variation is within 1% at all times and this difference could probably be absorbed by the manufacturer.

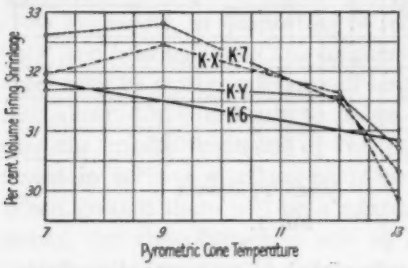

FIG. 2.

But the variation between Nos. 6 and 7 is within this limit also and these two are not considered to be identical. There is no doubt but that users can absorb considerable variations in feldspar but the more nearly the feldspar approaches uniformity the more likely are they to be free from trouble on this score.

IV. Cause for Variations Noted

It is the theory of the authors that the variations are due to the different compositions of the plagioclase. If the plagioclase in the two feldspars blended were of the same soda-lime ratio and this ratio the same as that of the feldspar one wished to produce, variations should be less apparent. The degree of weathering is also an important factor for the normative analysis which calculates loss on ignition and some of the excess alumina and silica as kaolin does not tell the true story. These oxides are more likely to be present as sericite and hydromicas of indefinite composition.

Two feldspars of the same mine are more likely to produce similar results than are two feldspars from different mines.

V. Conclusion

Blending is admitted as being far from a perfect device and considerations of the source of feldspars and the minor constituents of the analysis must enter before uniformity can be attained. Since it is impossible to consider more than two factors in the blending of two materials all but two of the factors should be uniform and this can only be obtained from one-mine materials.

MOISTURE EXPANSION OF GLAZES AND OTHER CERAMIC FINISHES[1]

By H. G. Schurecht and G. R. Pole[2]

ABSTRACT

Research for ascertaining why some glazes are more resistant to "moisture crazing" than others revealed the fact that certain glazes expand, because of the action of water, similarly to some of the ceramic bodies to which they are applied. Although a control of this type of expansion is very important in fitting glazes to bodies, it has not been previously considered. Its importance should be evident at once when it is considered that a large "moisture expansion" in a glaze or other finish is in many cases an indication that the glaze will not be so liable to craze when the ceramic ware or material on which it is used is exposed to moisture. This follows since the glaze and the body on which it goes and which is ordinarily very susceptible to this kind of expansion will then increase in size simultaneously and more nearly at the same rate. Such conditions lessen the tendency of the body expansion to cause tensile stresses in the glaze.

In this investigation specimens of various finishes were subjected to steam at 150 pounds per square inch for an hour because it was known that this treatment of such materials produces effects similar to those caused by long exposure to weather. This artificial weathering treatment caused in lustrous glazes an average expansion of 0.004%, in mat glazes 0.011%, in vitreous slip finishes 0.005%, and in porous slip finishes 0.033%. The moisture expansion of one of the mat glazes was 30% of the average obtained for a ceramic body having an absorption of approximately 12%. This proclivity of ceramic finishes to expand by the absorption of moisture can be controlled in their manufacture.

I. Introduction

It has been shown[3] that a type of delayed crazing found on glazed ceramic ware may in certain cases be caused by a gradual expansion produced by the action of moisture on the body during storage or use. It has also been demonstrated that by subjecting glazed bodies to steam at a pressure of 150 pounds per square inch some of the effects produced are very similar to those obtained by exposure to weather. Moreover, it was found[4] that this type of crazing may be prevented by adjusting the relative expansivity of the glaze with respect to the body so that the glaze is under a fairly high compression when the ware is removed from the kiln.

Preliminary studies indicated, however, that some of the porous slip

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[1] Publication approved by the Director of the Bureau of Standards of the Department of Commerce and by the National Terra Cotta Society.

Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (Terra Cotta Division). Received February 3, 1931.

[2] Research associates of the National Terra Cotta Society at the National Bureau of Standards.

[3] H. G. Schurecht, "Methods for Testing Crazing of Glazes Caused by Increases in Size of Ceramic Bodies," *Jour. Amer. Ceram. Soc.*, **11** [5], 271–77 (1928).

[4] H. G. Schurecht and G. R. Pole, "Effect of Water on Expansions of Ceramic Bodies of Different Compositions," Bur. Stand., *Jour. Research*, **3**, 331–41 (1929); *Jour. Amer. Ceram. Soc.*, **12** [9], 596–604 (1929).

finishes or engobes develop a "moisture expansion" similar in magnitude to that obtained in the body on which they go and hence that it is unnecessary to have such finishes in high compression in order to prevent "moisture crazing." It was also found that some glazes may be in less compression than others to prevent such crazing. This led to the belief that these glazes as well as the engobes develop a moisture expansion. The investigation was, therefore, continued to test this opinion and the results to date evidently confirm it.

II. Experimental Methods

Four different lustrous glazes, five mat glazes, five porous slip finishes, and two vitreous slip finishes were studied in this investigation. In one portion of the tests, bars of the glazes and other ceramic finishes, approximately 1 x 1 x 6 inches in size, were used as specimens. These bars were made by filling fireclay troughs with the raw glazes or engobes and firing them to the regular maturing temperatures of the finishes. These temperatures ranged from cones 3 to 6. After firing, the fireclay troughs were ground from the fused bars of glazes and engobes. Pyrex glass capillary reference tubes were then cemented in grooves which had been cut about five inches apart in the bars. The distances between these tubes were measured by means of a microscope comparator[5] and the bars were then subjected to steam at a pressure of 150 lbs./in.^{2} in an autoclave for one hour. After this treatment the specimens were cooled and the distances between the reference marks remeasured in order to determine the expansions produced. The specimens were then subjected to steam at a pressure of 300 lbs./in.^{2} for another hour to determine the additional expansion caused by this more severe treatment.

In another test the same finishes were applied to the outside surfaces only of cylindrical rings having 2-inch outside diameters as described in a previous article.[6] Each finish was tested on rings of the same bodies for which it was developed by the manufacturer. Two reference marks consisting of thin capillary Pyrex tubes cemented in holes approximately $^1/_4$ inch apart were established on the upper edge of each ring. The rings were cut open between these reference marks whose distances apart were then measured with a micrometer microscope. After this, the rings were subjected to steam at a pressure of 75 lbs./in.^{2} for one hour in an autoclave and cooled for a remeasurement of the distances between the marks. The

[5] The comparator used in this work was designed by C. S. Laubly, of the Bureau of Standards, and is described in "Shrinkage of Portland Cement," by J. C. Pearson, *Jour. Amer. Concrete Institute* (1921).

[6] H. G. Schurecht and G. R. Pole, "Methods of Measuring Strains between Glazes and Ceramic Bodies," Bur. Stand., *Jour. Research*, **5**, 97–103 (1930); *Jour. Amer. Ceram. Soc.*, **13** [6], 369–75 (1930).

increases noted in these distances resulted because the effect of moisture, absorbed during the treatment, expanded the finishes less than it did the bodies of the rings. When different finishes are on rings having the same body these increases become larger, therefore, as the susceptibility of the finishes to moisture expansion decreases. The results obtained are given in Table II and represent in every case the average obtained on three duplicate specimens after corrections were made for any discrepancy occurring in the temperatures at which the measurements were made. The variations between the results obtained on duplicates were usually less than ± 0.001 cm.

To determine the degree to which these finishes are subject to crazing as a result of this differential moisture expansion between them and the bodies, crazing tests were carried out on 4- by 4- by 1-inch tile made of the appropriate bodies as in the case of the rings. In these tests the treatment was the same as in the ring tests except that a second treatment at a steam pressure of 150 lbs./in.^{2} was also given. The results are incorporated in Table II.

III. Results on Bars of Ceramic Finishes

The results obtained on the bars made of the glazes and other ceramic finishes are given in Table I.

The lustrous glazes developed moisture expansions ranging between 0.001

TABLE I

MOISTURE EXPANSIONS OF GLAZES AND OTHER CERAMIC FINISHES WHEN SUBJECTED TO AN AUTOCLAVE TREATMENT

	Expansions (in %) of bars made of glazes and other ceramic finishes. (Average of 3 tests. Variations = ±0.0005%)	
	150 lbs./sq. in. steam pressure for one hour	300 lbs./sq. in. steam pressure for one hour
Lustrous glazes		
A	0.003	0.004
B	0.001	0.002
C	0.002	0.005
D	0.009	0.012
Mat glazes		
A	0.015	0.017
B	0.009	0.013
C	0.003	0.003
D	0.013	0.030
E	0.012	0.021
Porous slip finishes		
A	0.020	0.029
B	0.026	0.102
C	0.030	0.070
D	0.020	0.048
E	0.067	0.139
Vitreous slip finishes		
A	0.004	0.029
B	0.006	0.022

and 0.009% with an average of 0.004% when treated with steam at a pressure of 150 lbs./in.^{2} for one hour. When treated with steam at a pressure of 300 lbs./in.^{2} for one hour subsequent to the 150-pound treatment, the total expansions resulting from the two treatments ranged between 0.002 and 0.012%, with an average of 0.005%.

The mat glazes expanded 0.003 to 0.015% with an average of 0.010% when treated with steam at a pressure of 150 lbs./in.^{2} and on being subjected to the 300-pound treatment, the total expansions ranged between 0.003 and 0.030%, with an average of 0.017%.

The vitreous slip finishes developed moisture expansions ranging between 0.004 and 0.006%, with an average of 0.005% when treated with steam at 150 pounds; and when subsequently subjected to the 300-pound treatment the total expansions arising from the two treatments ranged between 0.022 and 0.029%, with an average of 0.026%.

The porous slip finishes expanded 0.020 to 0.067%, with an average of 0.033% as a result of the treatment at 150 pounds; when treated at 300 pounds the total expansions from the two treatments were between 0.029

TABLE II

THE EFFECT OF AUTOCLAVE TREATMENT ON THE TENDENCY OF GLAZED CERAMIC WARE TO CRAZE

Body	Ceramic finish	Appearance of glazed tile			Expansion (in cm.) of glazed rings from treatment with steam at 75 lbs./sq. in. for one hour (variation = ±0.001cm.)
		Before testing	After treatment with steam at 75 lbs./sq. in. for one hour	After treatment with steam at 150 lbs./sq. in. for one hour	
1	White lustrous glaze A	OK	OK	Medium crazing	0.0075
	White mat glaze A	OK	OK	OK	0.0070
	White mat glaze B	OK	OK	OK	0.0065
	Porous slip finish A	OK	OK	OK	0.0040
	Porous slip finish B	OK	OK	OK	0.0015
2	White lustrous glaze B	OK	OK	Badly crazed	0.0100
	White mat glaze C	OK	OK	Slightly crazed	0.0090
	Vitreous slip finish A	OK	OK	Badly crazed	0.0035
3	White lustrous glaze on C	Slightly crazed	Badly crazed		0.0075+*
	White mat glaze D	Medium crazing	Badly crazed		
	Vitreous slip finish B	OK	OK	OK	0.0040
	Porous slip finish C	Medium crazing	Badly crazed		0.0015+
4	White lustrous glaze D	Slightly crazed	Slightly crazed		0.0045+
	White mat glaze E	OK	OK	Badly crazed	0.0105
	Porous slip finish D	Slightly crazed	Slightly crazed		0.0090+
	Porous slip finish E	OK	OK	Slightly crazed	0.0020

* The expansions of rings which were crazed are marked plus (+) since some of the strain between the body and slip has been relieved by crazing of the slip.

and 0.139%, with an average of 0.078%.

In a previous work[7] some porous ceramic bodies were found to expand 0.055 to 0.125% as a result of this treatment with steam at 150 pounds for an hour. In comparison, the expansion of one of the mat glazes mentioned above was 0.015% when treated in this way; that is, the expansion of this glaze amounts to between 12.5 and 30.0% of that developed in the porous ceramic bodies previously tested.

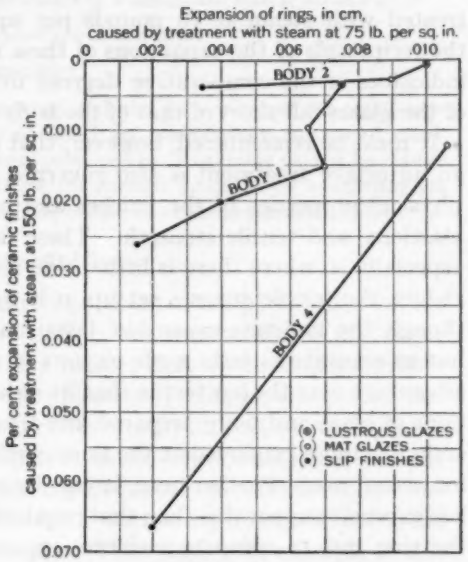

FIG. 1.—A comparison of the moisture expansions of ceramic finishes and expansions of rings with these finishes.

IV. Results with Ceramic Finishes on Rings

The results shown in Table II and obtained with the glazes and other ceramic finishes when they were applied to rings made of the appropriate bodies have in part been plotted in Figs. 1 and 2 against the corresponding results in Table I. The values obtained by the ring method are too low when the finishes craze since some of the strain between the body and finish is relieved by this crazing; and for this reason some of the data are not included in the figures. It is evident from the figures that, in general, those finishes which develop the least moisture expansion cause the rings made from a given body to expand the most when they were

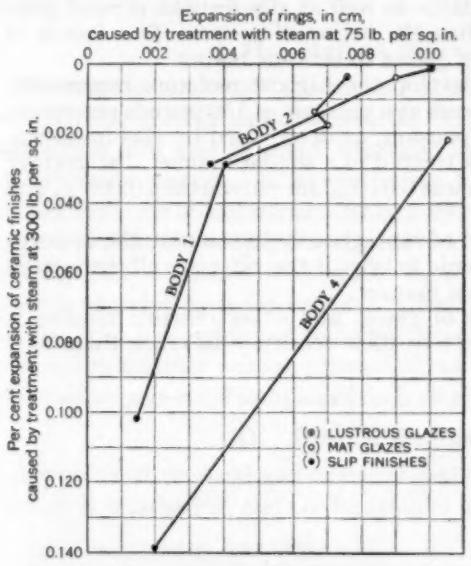

FIG. 2.—A comparison of the moisture expansions of ceramic finishes and expansions of rings with these finishes.

[7] "Methods for Testing Crazing of Glazes," *op. cit.*, p. 274.

treated with steam at 75 pounds per square inch for one hour; hence the reciprocals of the expansions of these rings may be used as qualitative indicators of the comparative degrees to which the moisture expansions of the glazes fall short of that of the body represented in the rings.

It must be remembered, however, that the expansion of the rings during an autoclave treatment is also governed to some extent by certain other physical properties of the finishes and bodies, such as, for example, the elasticity and tensile strength. These factors are always important and especially so where there is little or no moisture expansion in the finish to reduce the tensile stresses set up in it by the swelling of the body. Although the moisture-expansion tests made on rings are qualitative and not as accurate as tests made on bars of the finishes, the ring test has the advantage over the bar test in that its measurements are made on combinations of glaze and body prepared and treated under conditions almost exactly like those employed on the same combinations when they are prepared for actual use. Furthermore, it can be conducted in less time and with less expensive apparatus than that required for the bar test. In employing the ring test to compare moisture expansions of glazes it is, of course, necessary to use the same ring body fired to the same temperature for all of the glazes.

V. Summary and Conclusions

(1) Some mat and lustrous glazes as well as slip finishes expand similarly to porous ceramic bodies from the action of water. This fact is of fundamental importance in fitting glazes to ceramic bodies.

(2) In general, slip finishes develop the highest moisture expansions, and when they are treated with steam at a pressure of 150 pounds per square inch for one hour the average expansion, as determined by this investigation, amounts to 0.033%. When treated in a similar manner, the average expansion obtained for mat glazes was 0.011%, for vitreous slip 0.005%, and for lustrous glazes 0.004%.

(3) The ring test may be used advantageously to compare the approximate moisture expansions of ceramic finishes if the rings are all made from the same body treated in the same manner.

(4) The moisture expansions of glazes and other ceramic finishes is often more important with respect to their tendency to craze than their elasticity and tensile strength.

EXPERIMENTS IN WEATHERING PLASTIC FIRE CLAYS[1]

By Stuart M. Phelps[2] and C. G. Denney[3]

ABSTRACT

A description is given of the test method and the data obtained for small-scale weathering. Extensive data were also obtained on commercially weathered clays. The results obtained show that the changes produced by weathering cannot be readily detected by the usual test methods. Either the changes produced by weathering are over-estimated, or the present test methods do not measure the properties involved.

I. Introduction

This work was started some years ago as an attempt to learn of the changes in properties which occur during the weathering of fire clays. Producers and users of weathered clay believe that weathering materially reduces drying shrinkage, increases the plasticity, oxidizes the pyrite, etc. A certain semiflint clay is weathered commercially to make a very plastic and desirable bond clay and some plastic clays, when weathered, become too plastic for satisfactory use in making all-plastic clay brick. Some believe that very little may be expected from weathering unless the clay piles are systematically turned so as to expose all the clay. An example of this is a plastic clay which, after twenty-two years of exposure to weather without being disturbed, showed that a layer of only 18 inches had been appreciably affected. In the manufacture of many types of refractories and notably glasshouse, many believe that only weathered clay should be used to produce the best ware.

II. Method of Weathering

The experimental work was conducted on two typical plastic clays from central Pennsylvania and two from the St. Louis district. As a matter of curiosity a flint and semiflint were also included, each from the central Pennsylvania district. The weathering test was made on the roof of Mellon Institute of Industrial Research by placing the clays in two vertical lengths of 6-inch sewer pipe, at the bottom of which there was a perforated ceramic plate. Efforts were made to collect the water which filtered through the clay in order to make determinations for soluble salts, iron, etc., but this was not found to be practical for a number of reasons. The exposure to weather was for a period of two years and nine months, during which time large-sized samples of each clay were stored in the Laboratory.

III. Data on Weathered Clay

A number of physical and chemical determinations were made on these clays after weathering, and on the samples which were stored. These data

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are presented in Table I. It will be seen that the benefits which might be expected by weathering were not obtained. After making allowances for experimental errors, there was found to be little significant difference in the properties determined. The possible exceptions are the drying shrinkage of plastic clay No. 1 which increased as a result of weathering

TABLE I

DATA ON CLAYS FROM SMALL-SCALE WEATHERING EXPERIMENTS
(Time of weathering, 2 years 9 months)

	Pennsylvania				Missouri							
	Plastic clay No. 1		Plastic clay No. 2		Plastic clay No. 3		Plastic clay No. 4		Flint clay No. 5		Semiflint clay No. 6	
Test	Unweathered	Weathered	Unweathered	Weathered	Unweathered	Weathered	Unweathered	Weathered	Unweathered	Weathered	Unweathered	Weathered
Water of plasticity	23.6	27.9	22.1	22.2	22.0	19.8	22.7	22.3	21.7	21.0	19.0	18.2
Volume drying shrinkage	13 0	19.2	12.2	12.2	20.7	16.2	21.6	22.1	8.9	8.8	11.5	10.0
Ferric oxide content	3.30	3.26	3.30	2.89	2.62	2.54	2.05	2.09	1.04	1.07	1.31	1.20
Volume firing shrinkage 1400°C.			25.5	22.0					22.9	22.9	21.3	22.5

along with an increase in the water of plasticity. The shrinkage of clay No. 3, however, decreased as a result of weathering. In clay No. 2 the iron content showed an appreciable decrease through weathering.

It was expected that changes of a larger order than these would be derived from weathering for such a period, in view of the comments made by plant men. The small scale of the weathering and the fact that the samples were not turned during the period may explain the nature of the results. It was for these reasons that samples of commercially weathered and unweathered clays were obtained from manufacturers for study.

Clay "A" is from the St. Louis district and represents a bond clay used in hand-made mixes. The weathered sample had been exposed for 18 months during which time the piles had been systematically turned. Special care was taken to see that both the weathered and unweathered clays were identical. Clay "B" represents a Pennsylvania bond clay which is widely used as a high-grade bond clay. The duration of the weathering is not known, but it received the regular treatment used for this clay. Clay "C" is a plastic fire clay from the Chicago district, the weathered clay representing 5 months' exposure of the face of the pit, while the unweathered sample came from the same section of the pit, but contains considerably less iron. Since clays "B" and "C" are not strictly comparable as to the treated and untreated samples, these cannot be compared to the same degree as clay "A."

IV. Tests on Commercially Weathered Clays

The data presented in Table II show the P.C.E. and partial chemical

analysis of the three clays in both conditions. Clay "A" shows that the result of weathering produced almost no changes, except a slight reduction in iron oxide content. The small differences in the other two clays may or may not be the result of weathering.

In Table III there is given the water of plasticity, green strength, and

TABLE II

P.C.E. AND CHEMICAL ANALYSIS OF CLAYS AS MINED AND AFTER COMMERCIAL WEATHERING

	Clay A			Clay B			Clay C		
Test	As mined	Weathered	Diff.	As mined	Weathered	Diff.	As mined	Weathered	Diff.
P.C.E.	30	30	0	31	31	0	30	30	0
Ignition loss	10.27	10.27	0	10.60	9.96	−0.64	10.04	10.48	+0.44
Ferric oxide	2.91	2.64	−0.27	1.69	1.57	−0.12	2.10	4.24	+2.14
Alkalis	0.41	0.37	−0.04	1.37	1.42	+0.05	0.55	0.37	−0.18
Soluble salts	0.41	0.35	−0.06	0.17	0.21	+0.04	0.21	0.22	−0.01

TABLE III

PLASTICITY, STRENGTH, AND FIRING PROPERTIES OF CLAYS AS MINED AND AFTER COMMERCIAL WEATHERING

	Clay A			Clay B			Clay C		
Test	As mined	Weathered	Diff.	As mined	Weathered	Diff.	As mined	Weathered	Diff.
Water of plasticity	20.4	20.1	−0.3	22.8	23.3	+0.5	17.9	18.5	+0.6
Transverse strength of unfired clay (av. of 6)	304	217	−87	316	288	−28	193	219	+26
Volume firing shrinkage during draw trial									
1000°C	5.5	6.5	+1.0	7.3	6.0	−1.3	3.2	4.4	+1.2
1100°C	9.5	10.4	+0.9	16.0	15.0	−1.0	6.4	8.5	+2.1
1200°C	13.1	13.9	+0.8	19.9	20.5	+0.6	8.4	9.7	+1.3
1300°C	14.9	15.2	+0.3	23.2	22.7	−0.5	9.5	11.8	+2.3
1400°C	16.7	18.4	+0.7	24.9	21.8	−3.1	10.5	12.4	+1.9
1500°C	20.9	22.7	+1.8	10.7	8.0	−2.7	16.5	18.6	+2.1

the volume firing shrinkage of the six clays. It will be noted that the water of plasticity has not been changed; the transverse strengths of the green clay show for clay "A" an appreciable decrease through weathering and likewise, but to a small degree, in clay "B"; while with clay "C" the strength increased. The difference in firing shrinkages during a draw trial from 1000 to 1500°C are of a small order and do not indicate an appreciable change as a result of weathering.

It would be logical to expect a breaking down of the clay into its individual particles through weathering, and to learn of this a wet-screen analysis was conducted on the clays. These data are given in Table IV. The data for sample "A" show that this clay was broken down considerably by weathering. The same is true to a smaller extent, of clay "B"; while clay "C" shows a very small change. The results of a settling test on clay

TABLE IV

WET SCREEN ANALYSIS OF CLAY AS MINED AND AFTER COMMERCIAL WEATHERING

(Percentage Passing Various Screens)

Screen mesh no.	Clay A			Clay B			Clay C		
	As mined	Weathered	Diff.	As mined	Weathered	Diff.	As mined	Weathered	Diff.
40	77.8	94.1	+16.3	95.7	95.3	− 0.4	79.2	81.9	+2.7
60	63.6	85.7	+22.1	80.3	85.5	+ 5.2	66.4	70.4	+4.0
80	54.0	77.1	+23.1	67.6	76.9	+ 9.3	57.9	61.8	+3.9
100	48.4	71.7	+23.3	61.1	72.6	+11.5	52.0	56.7	+4.7
120	42.6	64.5	+21.9	54.2	67.9	+13.7	46.6	50.6	+4.0
160	39.1	60.6	+21.5	51.2	65.4	+14.2	43.3	46.9	+3.6
200	32.8	55.5	+22.7	45.5	58.2	+12.7	35.7	36.5	+0.8
325	18.3	17.3	− 1.0	38.4	28.8	− 9.6	15.2	21.4	+6.2

suspended in distilled water are shown in Fig. 1, from which it will be seen that the weathered "B" clay which is in graduate "B-B" does not settle as rapidly as the unweathered "B." Contrary as many of the results of this study are, the weathered "C" clay in graduate "C-C" has settled more rapidly than the unweathered "C." Unfortunately samples of the "A" clay were not available for the settling test.

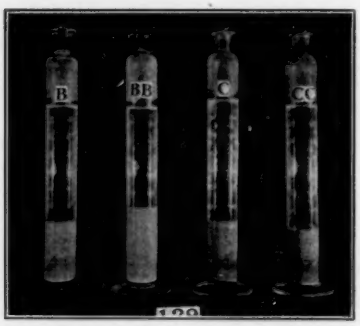

FIG. 1.—Comparison of unweathered and weathered clays in settling test.

Weathered clays are believed to have the ability of bonding or holding higher percentages of flint clay or grog than the unweathered clays. There is no entirely satisfactory test which gives a numerical value to such a property. For this purpose, however, a test was used which was developed for another study, but this is believed to indicate such properties. The test method consists of molding a perfect sphere of the clay and dropping this from a definite height to a plane surface. The area of contact or deformation is measured and used as an index to consistency, mobility, and the other characteristics which constitute "working properties." In testing the weathered or unweathered clays, 20% was mixed with 80% of 20-mesh flint clay and after aging for four days, the 3-inch spheres were molded under a pressure of 3000 pounds. These spheres were dropped nine feet to a horizontal plane surface and the area of the contact of each was measured with a planimeter. For clay "A" the reduction in area due to weathering was 2%, for clay "B," 12.3%, and for clay "C," 2%. These results show that under comparable conditions clay "B" has increased appreciably in bonding power as a result of weathering. The increase of 2% in the cases of the "A" and "C" clays is considered too small to be significant.

The clays were also tested in the thermal expansion equipment where their linear change was measured in thousandths of an inch when heated from room temperature to 1000°C in twenty hours. The difference in expansion or shrinkage between the weathered and unweathered clays was less than 0.5%.

V. Tests on Commercial Brick

At this time during the study an opportunity was presented to conduct tests on two lots of plastic clay brick which differed only in that they were made from weathered and unweathered clays. In the transverse strength test the unweathered brick showed an average of 1695 pounds per square inch; while the weathered showed 1649 pounds. The cold crushing strength of the unweathered was 3136 pounds per square inch; while the weathered brick gave 2578 pounds. The average porosity of the brick made from the unweathered clay was 20.9%; while those made from the treated clay showed 18.3%.

VI. Conclusions

The results which have been obtained may in part be accounted for by the necessity of conducting the tests on both the weathered and unweathered clays at the same time to insure accuracy, and it is obvious that this requires storage of the unweathered clay during which time aging effects similar to weathering could take place.

The most common occurrence of iron in clays is in the form of pyrite and this is very stable to weathering; while the clays which contain iron as marcasite or siderite are more apt to weather. The various iron compounds in clays may be affected by bacteria during the weathering process which would tend to distribute them more uniformly throughout the clay. This beneficial result from weathering is more likely to take place through a mechanical subdivision, especially when the pyrite is present as an agglomerate of fine particles.

Summarizing all of the Laboratory data obtained on clays weathered on a small scale and those from commercial practice, as well as the brick made from both weathered and unweathered clays, it appears that there are no entirely satisfactory methods of obtaining the numerical values of the changes which take place during the weathering of clays. It may be that for such a study tests should be designed with an aim to greater accuracy than those regularly used in the routine testing of clays. It is believed that the effects which are considered most beneficial from weathering could be produced to a large degree by a very fine grinding, and by treatment with suitable organic matter and electrolytes.

Bibliography

(1) Ashland Firebrick Company, "Weathering of Clay," *Chem. Met. Eng.*, **9**, 332 (1911).
(2) G. E. Thomas, "Settling and Filtering of Fire Clays," *Trans. Amer. Ceram. Soc.*, **14**, 399–406 (1912).
(3) L. B. Rainey, "Weathering of Fire Clays in the Manufacture of Face Brick and Paving Block," *ibid.*, **16**, 405–408 (1914).
(4) W. Hugill and W. J. Rees, "The Influence of Exposure on the Chemical and Physical Properties of Certain Fire Clays," *Jour. Soc. Chem. Ind.*, **43**, 985 (1924).
(5) S. M. Phelps, Discussion on "The Disintegration of Clay Refractories in Iron Blast Furnaces," *Jour. Amer. Ceram. Soc.*, **7**, 716–17 (1924).
(6) W. J. Rees, "The Weathering of Clays," *Pottery Gaz.*, **50** [579], 1395 (1925).
(7) "The Weathering of Clays," *Chem. Age*, **13** [340] [Suppl.], 13 (1925).
(8) Alexander Scott, "Sagger Marls and Sagger Making," *Pottery Gaz.*, **51** [593], 1715–17 (1926).
(9) J. W. Hepplewhite, "Weathered Clay Imparts Quality to Semivitreous Bodies," *Ceram. Ind.*, **13** [3], 262 (1929).
(10) H. Harrassowitz, "Silicon, Aluminum, and Iron in the Change of Weathering Processes," *Z. angew. Chem.*, **43** [9], 185–90 (1930).

CERAMIC ABSTRACTS

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Abrasives

Relation between properties and use of grinding wheels. A. GUILLEAUME. *Ber. deut. keram. Ges.*, **11** [5], 284 (1930).—The most frequently used raw materials in the grinding wheel industry are artificial corundum and silicon carbide. Their hardness is their chief and most important property. Hardness, toughness, and ability to splinter may be varied by adding different components and by using different methods of production. The alumina content for corundum is between 93 and 99.5%. The silicon carbide is used only from the inner crystallized zones of the furnace. Hardness of grinding wheels is the binding power with which the grains are held by the bond.

The raw materials used for bond are the same as those used in other ceramic industries: clays, feldspar, and fluxes. Compositions of grinding wheel bond materials in comparison with other ceramic materials are given. The bond should be a tough glass. The manufacturing methods are pressing, casting, and stamping. The article gives information on firing time and cooling. Finishing and testing for hardness is described. There is a new sandblast method for testing hardness. The advantage of ceramic binders over organic binders is the high porosity, although lately the same high porosity has been obtained with organic binders. G. gives interesting information about the technique of grinding. Each grain is a cutter that will plane off a certain quantity and after a certain time this single grain is used up and should splinter off or fall out to develop new, fresh, active cutters. The relation between the grinding material and the material to be ground is demonstrated. Different sorts of grinding are mentioned, *e.g.*, sharp edge, round cutting, plane grinding, etc. G. also gives some idea for what material certain grades of grinding wheels should be used and mentions the wide use of the grinding wheel in other industries, *e.g.*, finishing steel, glass, pipes, etc. I.R.

Design refinements point to improved practice. EDWARD S. HECK. *Abrasive Ind.*, **12** [1], 33 (1931).—The U. S. Electrical Tool Co. has brought out a grinder having three wheel speeds by meshing V-disks of graphitized micarta controlled by a foot pedal and hand lever. The Standard Electrical Tool Co. has introduced boiler plate hoods weighing 320 lb. each, arranged to guard a 30- x 4-in. high-speed wheel. Advances were made in adapting grinding to processes formerly done by cutting-machine tools. Cut-off machines using $^{3}/_{32}$-in. disks have demonstrated their value over other methods of cutting off stock. The A. P. de Sanno & Son Co. mounts the motor and the grinding spindle on a counterbalanced, swinging table. A light surface grinder designed by the Diamond Machine Co. coördinates by the hydraulic system the traverse and cross-feed. The roll-grinding machine designed by the Cincinnati Grinders, Inc., exhibits an interesting feature in the cambering mechanism. The heavy-duty chucking internal grinding machine introduced by the Heald Machine Co. is the largest internal grinder of its type and has built-in hydraulic control and table drive. A number of other outstanding developments in the grinding field are described. E.P.R.

Cam grinder provides even speed. ANON. *Abrasive Ind.*, **12** [1], 35–36 (1931).—The Churchill Machine Tool Co., Ltd., has a cam-grinding attachment which gives an even surface speed by retarding the rotation of the work as it swings away from the grinding wheel and accelerating the speed as it advances toward the grinding wheel. Illustrated. E.P.R.

Honing machine. ANON. *Abrasive Ind.*, **12** [2], 51 (1931).—Barnes Drill Co. has a single-spindle honing machine hydraulically operated and equipped with quick pick-off gears for speed changes. E.P.R.

Grinding a cutter of tungsten carbide. ANON. *Abrasive Ind.*, **12** [2], 47 (1931).—When setting a new blade an indicator should be used to save time in grinding. For grinding all tungsten carbide cutters a 60-grit wheel is good, with a wheel pressure not in excess of 0.002-in. per tooth. Wheel speed is not critical except for safety but generally ranges between four and six thousand surface feet per minute. Wheels should be dressed frequently to prevent glazing and checking. Finish grinding is not necessary but hand honing is, where arc face milling grinding cannot be used. E.P.R.

Grind tungsten carbide tools. ANON. *Abrasive Ind.*, **12** [2], 51 (1931).—The Black & Decker Mfg. Co. has a new 10-in. precision grinder designed especially for grinding cemented tungsten carbide tools which will sharpen to the proper angle accurately. It is available in two types: one accommodating a 10-in. cup-type wheel on the right spindle and a 10-in. straight-side wheel on the left, and the other type accommodating two 10-in. cup-type wheels, one on each spindle. E.P.R.

Grinder operates at a constant speed. ANON. *Abrasive Ind.*, **12** [1], 37 (1931).—Hammond Machinery Builders, Inc., has a new, constant, peripheral speed grinder which operates at 9000 surface ft. per min. for bakelite and rubber-bonded wheels and may be adjusted for use with vitrified wheels. It uses 16-, 18-, 20-, and 24-in. wheels and may be obtained with $7^1/_2$-, 10-, or 15-h.p. motors. E.P.R.

Roll-grinding machine presents unusual design features. ANON. *Abrasive Ind.*, **12** [2], 49–50 (1931).—The Farrell-Birmingham Co. has designed a machine for finishing the vertical rolls of a universal structural beam mill. The rolls are 42 in. in diameter and 18-in. face. They have a surface embodying a combination of a taper and a curve. The middle portion of the face is ground to a true radius and the sides with a straight taper; usually 4 to 8°. E.P.R.

Grinds linotype knives. ANON. *Abrasive Ind.*, **12** [2], 50–51 (1931).—Samuel L. Rogers & Co. has a machine for the precision grinding of linotype and intertype back mold and trimming knives. E.P.R.

Wheel has metal back. ANON. *Abrasive Ind.*, **12** [2], 52 (1931).—The Peninsular Grinding Wheel Co. has designed disk grinders which fasten to a metal back with standard cap screws extending through the metal back and into nuts imbedded in the wheel. E.P.R.

Multiple speed-swing grinder. ANON. *Abrasive Ind.*, **12** [1], 36 (1931).—The Black & Decker Mfg. Co., has a swing-frame grinder with three speeds available with maximum wheel sizes of 12, 16, 18, 20, and 24 in., and a primary cutting speed of 6000 or 9000 surface ft. per min. E.P.R.

Designs high-speed spindles. ANON. *Abrasive Ind.*, **12** [1], 22–23 (1931).—Abrasive surface grinding with high-speed spindles by the Ex-Cell-O Aircraft & Tool Corp. has extreme accuracy and dependability due to high-speed ball bearings. E.P.R.

Cams require accurate grinding. ANON. *Abrasive Ind.*, **12** [1], 23 (1931).—The grinding operation consists of finishing valve timing cams for rotary-type air-cooled Curtiss engines at the plant of the Curtiss Aeroplane & Motor Co. The machine is a Norton special cam grinder fitted with an alundum wheel $1^5/_{16}$ in. in diameter and $1^1/_8$-in. face. The cam contour is rough ground with a 36 medium-grade wheel and finished after heat treatment with a 60-grit soft grade. E.P.R.

Grinding increases aircraft engine dependability. FRED B. JACOBS. *Abrasive Ind.*, **12** [1], 14–17 (1931).—Description of manufacturing operations embodying grinding at the Curtiss Aeroplane & Motor Co., is given. E.P.R.

Abrasives aid airplane industry. JOHN L. ALEXANDER. *Abrasive Ind.*, **12** [1], 26 (1931).—The manufacturing, research, and development division of the abrasive industries will have to become better acquainted with the problems of the aircraft manufacturer to develop materials and methods to fit his requirements. E.P.R.

Cut-off machine is well guarded. ANON. *Abrasive Ind.*, **12** [2], 50 (1931).—This cut-off machine was designed by Andrew C. Campbell, Inc., for ease and safety of operation in making available the high-cutting speeds and efficiency of the abrasive-disk cutting method. The spindle of the machine is driven at 5000 r.p.m. by a motor of $7^1/_2$ h.p. The spindle is 1 in. in diameter and carries an abrasive disk of 12-in. diameter and $^3/_{32}$-in. thickness. The width of the machine is 33 in., the length 45 in., and the height 58 in. Illustrated. E.P.R.

Grinder has adjustable suction dust guard. ANON. *Abrasive Ind.*, **12** [1], 35 (1931).—The Stanley Electric Tool Co. has four 10-in. electric grinders with exhaust-type wheel guards, adjustable dust shields, and full ball-bearing totally enclosed motors, $^3/_4$ in. and 1 h.p., in both bench and pedestal styles. The grinder uses 10- x 1- x $^3/_4$-in. wheels. The distance between the wheels is $14^1/_2$ in. E.P.R.

Skate grinding. W. M. METCALFE. *Abrasive Ind.*, **12** [1], 25–26 (1931).—M. discusses grinding skates in a slack season. E.P.R.

Instructions in polishing wheel set-up. ANON. *Abrasive Ind.*, **12** [1], 42 (1931).—Instructions for setting up new and used polishing wheels have been issued by the Excelsior Tool & Machine Co. The polishing wheel should be placed on the machine spindle, or preferably a wheel-surface truing machine, for removing irregularities from the circumference. True the face of the wheel with an abrasive brick, file, or saw blade and round the edges, mark the direction the wheel should rotate and see that it always revolves in the same direction. Remove the wheel and coat with thin glue made for this purpose. Brush with the nap of the wheel and when thoroughly dry, smooth the face with rough sandpaper and coat again with glue and roll in 120 abrasive, allowing wheel to dry. Again glue and roll in 46–48–120 or whatever grain abrasive is required; allow to dry, glue, and roll again in the same abrasive. Oil and grease wheels should be glued on both sides of the wheel to prevent oil or grease from soaking through the sides and working its way under the grinding surface. The finer the abrasive, the thinner the glue should be. Glue should be of the best quality for this purpose and distilled or rain water should be used to eliminate chemical action. Mix only enough glue for the day's run and use fresh glue daily. A well-glued, 46-grain wheel should go over a surface of material of 40 to 50 sq. ft. before it is worn out. Balance the wheel using wood screws or roofing nails and lead washers. E.P.R.

Machine polishing. II. ROBERT T. KENT. *Abrasive Ind.*, **12** [1], 38–42 (1931).—Substitution of machine polishing for handwork represents a tremendous saving. Variables of the machine in its relation to the work and manufacturing conditions are discussed. Most effective wheel and work speeds, pressure and cushioning, contact oscillation, types of fixtures, and machine vibration are variables of the machine which K. considers in detail. Typical polishing machines of the various types in common use are described with reference to the best practice in their use in the shop. For Part I see *Ceram. Abs.*, **10** [2], 85 (1931). E.P.R.

New buffer and polisher. ANON. *Brass World*, **27** [1], 10 (1931).—A new style of buffer and polisher announced by the Hisey-Wolf Machine Co. has open-type spindle extensions and is manufactured in 3-, 5-, and $7^1/_2$-h.p. sizes. The machine has "Texdrive" power transmission. E.P.R.

Polisher with independent spindles. ANON. *Brass World*, **27** [1], 6 (1931).—Independent operation of the spindles of a new twin-spindle polishing lathe is featured by Chas. F. L'Hommedieu and Sons Co. E.P.R.

Burnishing machine with automatic discharge. ANON. *Brass World*, **27** [1], 4 (1931).—N. Ransohoff, Inc., has a new type of ball burnishing machine which automatically separates the material being burnished from the balls. Where parts were formerly polished one at a time by hand, batches of from 100 to 100,000 are now ball burnished. E.P.R.

Automatic features lead polishing advances. ANON. *Abrasive Ind.*, **12** [2], 56–58 (1931).—Demand for highly-finished surfaces has speeded up polishing and buffing developments for mass production. A number of the latest innovations for polishing steels of stainless, chromium, or chrome-nickel types are discussed. E.P.R.

Polishing aluminum. ANDREW V. RE. *Abrasive Ind.*, **12** [1], 42 (1931).—Polishing of aluminum alloy is not any more difficult than polishing brass, copper, etc. For aluminum castings Nos. 80, 120, and 150 abrasive, emery, or manufactured alumina is used. On color buffing, a small wheel can be used. By using good coloring rouge and a little paraffin now and then it will keep the cloudy appearance from the aluminum and will give a good finish. E.P.R.

Finishing stainless and plated caps. ANON. *Abrasive Ind.*, **12** [2], 53–55 (1931).—

Successful application of the fundamentals of automatic polishing and buffing is the outstanding feature of the finishing practice at the Easy-on Cap Co., division of the Eaton Axle & Spring Co. The polishing operations are adapted to ordinary, low-carbon steel, 18-chromium steel, and 18–8 chrome-nickel steel. E.P.R.

Special rouge for pewter ware. ANON. *Brass World*, **27** [1], 6 (1931).—Zucker Sons' Co., Inc., announces a special rouge in several grades, for semifinishing as well as for final coloring of pewter ware. E.P.R.

Finishes for ground work are standardized. R. E. W. HARRISON. *Abrasive Ind.*, **12** [1], 18–22 (1931).—The cheapest way of securing accuracy within the closely-specified limits and finish is by precision grinding. H. describes a simple apparatus for determining the quality of ground finishes by the sound test and draws some interesting conclusions. He points out that there is no available short-cut method of obtaining ultrafine finishes with a minimum of initial wear and that standardization of finishes can be attained at a low cost. E.P.R.

Simplify abrasive grain sizes. ANON. *Nat. Glass Budget*, **46** [38], 26 (1931); *Amer. Glass Rev.*, **50** [16], 14 (1931).—The Division of Simplified Practice of the Bureau of Standards, recently announced that the simplified practice recommendation covering allowable limits for the sizing of aluminium oxide and silicon carbide abrasives for polishing uses and grinding wheel manufacture has been approved by the industry for publication. E.P.R.

Wheel standardization reviewed. ANON. *Abrasive Ind.*, **12** [2], 38–39 (1931).—Simplification of grinding wheel sizes and shapes was discussed at a recent conference in Washington. E.P.R.

Grain-size standards perfected. J. S. FOLEY. *Abrasive Ind.*, **12** [2], 55 (1931).—Master samples of aluminium oxide polishing grain are available E.P.R.

Development phase marks year's abrasive advance. FRED B. JACOBS. *Abrasive Ind.*, **12** [2], 22–27 (1931).—Abrasive grain is produced on a more scientific basis. The growing demand for special grinding equipment resulted in the design of several single-purpose machines insuring highest possible production. E.P.R.

Year's progress in abrasive industry. ANON. *Abrasive Ind.*, **12** [2], 27 (1931).—The various happenings of importance in the abrasive industry occurring during the past year are listed by the month of their occurrence. E.P.R.

New England abrasive firm passes century mark. HERBERT R. SIMONDS. *Abrasive Ind.*, **12** [1], 24–25 (1931).—The history of the development and use of natural grindstones in the U.S. is closely associated with the history of Lombard & Co., Inc., Boston, now celebrating the completion of over 100 years of continuous marketing of grindstones, grinding wheels, and abrasives. E.P.R.

Canadian abrasives industry. ANON. *Can. Chem. Met.*, **15** [1], 35 (1931).—This industry includes two main divisions, the natural abrasives industry and the artificial abrasives and abrasive products industry. In the former division, selling value of products in 1929 amounted to $122,684, compared with $119,715 in 1928, and included diatomite, $10,330; grindstones, pulpstones, and scythestones, $106,354; and volcanic dust, $6000. Manufacture of artificial abrasives and abrasive products were valued at $8,961,951 in 1929, an increase of 26% over 1928. The principal products were fused alumina, $4,974,789, silicon carbide, $2,577,033, and abrasive wheels, $819,884. Imports of abrasives were appraised at $4,552,160, a 9.7% increase over 1928. Exports of artificial abrasives, including silicon carbide accounted for more than 97% of the total of $3,915,917. E.J.V.

High-speed grinding in Great Britain. REVERE CHAPELL. *Abrasive Ind.*, **12** [2], 37–38 (1931).—Descriptions of abrasive machinery in Great Britain are given together with a discussion of the comparison between American and British abrasive

practices. The opportunity in grinding in Great Britain lies in the high-speed field. The precision machine tool field is almost exactly like that of America and the British shops have many American grinders but the off-hand grinding field has hardly been touched. E.P.R.

German agate grinding industry adopts modern methods. HUBERT HERMANNS. *Abrasive Ind.*, **12** [2], 40–41 (1931).—H. outlines the method that has been followed for generations by the German agate grinders in a valley of the Hunsrueck mountains, and states that the old methods are gradually giving away to the new, wherein electrically-driven manufactured abrasive wheels are replacing the water-driven grindstones. Illustrated. E.P.R.

CATALOGUES AND BULLETINS

New method of grinding wheels. NORTON CO. *Abrasive Ind.*, **12** [1], 37 (1931).—This booklet explains the marking of the company's products. A section is devoted to an explanation of the meaning of controlled structure in the manufacture of grinding wheels. Illustrated. E.P.R.

Abrasive data. ANON. *Abrasive Ind.*, **12** [2], 58 (1931).—An attractive 28-page illustrated booklet issued by the Federal Abrasives Co. describes various abrasives and their production. Tables are included which give sieve standards, the weight per cu. ft. of abrasive grain, and the physical and chemical properties of refractory materials. Illustrated. E.P.R.

Snagging equipment. ANON. *Abrasive Ind.*, **12** [2], 52 (1931).—Three bulletins on high-speed snagging machines recently have been issued by Norton Co. The 16- and 24-in. swing-frame grinders made by the company are described in two of the bulletins and the 30-in. floor-stand machine in the third. Features of design are illustrated and specifications given with descriptions of the operating characteristics. E.P.R.

Car-wheel grinder. ANON. *Abrasive Ind.*, **12** [2], 52 (1931).—The Norton Co. has an improved 44-in. car-wheel grinding machine. Specifications and line drawings of side elevation and floor plans are shown. Illustrated. E.P.R.

Equipment catalogue. ANON. *Abrasive Ind.*, **12** [2], 58 (1931).—Catalogue No. 24 issued by the J. G. Blount Co. lists a line of grinders, buffers, and lathes. It describes (1) wet tool grinders of the belt and motor-driven types, (2) buffers and grinders of belt-driven types, (3) motor-driven buffers and grinders, and (4) speed lathes of belt and motor-driven types. E.P.R.

Polishing equipment. ANON. *Abrasive Ind.*, **12** [1], 37 (1931).—Leiman Bros. has issued a catalogue of machines and equipment for polishing, dust collecting, rolling, sand-blasting, pumping, grinding, etc. E.P.R.

Polishing data and machines. ANON. *Abrasive Ind.*, **12** [2], 58 (1931).—A complete line of polishing, buffing, and plating supplies and equipment is covered in a 271-page catalogue recently issued by the Crown Rheostat & Supply Co. The engineering section is devoted to data and information on modern polishing, buffing, and plating practice. Formulas, tables, and conversion factors are given. E.P.R.

Catalogue on grinder. ANON. *Abrasive Ind.*, **12** [1], 37 (1931).—A catalogue, H-301, issued by the Landis Tool Co., describes its new type 30-roll grinder, built in 36-, 48-, and 60-in. swings in lengths of 10 to 24 ft. in increments of 2 ft. Illustrated. E.P.R.

Grinding machines. ANON. *Abrasive Ind.*, **12** [2], 52 (1931).—Churchill Machine Tool Co., Ltd., has an open-side surface grinder, 19-in. crankshaft regrinding machine, automobile brake-drum grinder, and car-wheel grinder. Complete specifications are given of each machine. E.P.R.

Durez molder. ANON. *Abrasive Ind.*, **12** [2], 47 (1931).—General Plastics, Inc., North Tonawanda, N. Y., is distributing the initial number of The Durez Molder, a publication devoted to the use of synthetic gum molding compounds for making a variety of ornamental articles. The material also is used as a bond in grinding wheel manufacture. E.P.R.

PATENTS

Feed mechanism for grinding machines. CHARLES E. VAN NORMAN. U. S. 1,788,475, Jan. 13, 1931. A grinding machine having feed mechanism including a ratchet, a pawl carrier movably mounted adjacent the ratchet, a pawl movably mounted on the pawl carrier and engageable with the teeth of the ratchet, means for moving the pawl carrier periodically to cause movement of the pawl and ratchet, and manually-operable mechanism having engagement both with the pawl and the pawl carrier for disengaging the pawl from the ratchet and moving the pawl carrier out of the range of the means.

Manufacture of abrasive article. JAMES S. SMYSER. U. S. 1,788,600, Jan. 13, 1931. The method of coating a sheet of material with abrasive particles which comprises rendering the sheet both conductive and adhesive and, by oppositely charging the conductive sheet and abrasive particles in the region of the sheet, electrostatically depositing the abrasive particles upon the adhesive surface of the sheet.

Grinding-wheel adapter. ARCHIE D. ROBINSON. U. S. 1,788,634, Jan. 13, 1931. The combination with a grinding wheel and an arbor on which it is to be mounted, the wheel having a bore extending axially therethrough and larger in diameter than the arbor, of a single member located entirely within the bore and frictionally held to the wall thereof, a series of spring fingers on the member angularly spaced thereabout and directly engaging the arbor for centering it in the bore preliminary to clamping the wheel to the arbor, flanges for engaging opposite end faces of the wheel, and means for clamping the wheel between the flanges.

Grinding hobs. CARL G. OLSON. U. S. 1,788,737, Jan. 13, 1931. The method of grinding a hob having a spiral series of relieved teeth which includes the steps of positioning a grinding wheel with its axis of rotation in a plane substantially normal to the hob helix, rotating the wheel and the hob and effecting relative reciprocation between the wheel and the hob to effect the grinding of one side of each of the relieved teeth, reversing the position of the wheel to cause the latter to assume a position substantially 180° removed from the first position and vertically adjusting the position of the grinding wheel contemporaneously with the reversal thereof so as to effect the proper tangential engagement of the grinding wheel with the sides of the hob teeth at the front thereof.

Machine for centerless grinding. AXEL GUSTAF EMANUEL HULTGREN. U. S. 1,789,408, Jan. 20, 1931. In a machine for centerless grinding of surfaces of revolution or regular polygonal surfaces a grinding wheel and work-supporting members, one of the members being constituted by a rotating wheel, at least one of the members being mounted to freely rock on a rigid support, the axis of the work being substantially parallel to the axis of the rocking movement of the last-mentioned member, the latter being provided at each side of a plane determined by the two axes mentioned with a work-engaging surface.

Grinding machine. HARRY G. MILLER. U. S. 1,789,490, Jan. 20, 1931. A machine for grinding valve tappets, etc., comprising, in combination, a rotatable grinding disk, an oscillatory arm mounted for oscillation in continuous reciprocation during grinding operations about an axis that lies in the plane of rotation of the grinding disk and below the axis of rotation thereof, means for limiting the range and adjustably

determining the field of reciprocation, a turret head carried by the arm, the head being mounted so as to be rotatable about an axis that is parallel with the axis of the arm, a tubular work-holding chuck member mounted for rotation in the turret, and common means for driving the tubular member and grinding disk including belting having a set of pulleys located adjacent to the axis of oscillation of the oscillatory arm and upon an axis transverse thereto.

Grinding machine. GERARD A. DE VLIEG. U. S. 1,789,544, Jan. 20, 1931. The method of grinding cutters having a plurality of helical cutting edges which comprises reciprocating the cutter across a grinding element, separating the cutter from the grinding element at appropriate times, and imparting a rotary motion in one direction to the cutter in timed relation to the reciprocatory motion, this relation being such that during each separation one or more edges are skipped in passing from one edge to another edge.

Grinding machine. CHARLES H. NORTON. U. S. 1,790,245, Jan. 27, 1931. A grinding machine comprising a base, a work support, a slide movable toward and from the support, a grinding wheel rotatably mounted on the slide, a micrometer cross-feed mechanism including an adjustable stop to feed and accurately position the wheel relative to a work piece, a diamond, precision mechanism for accurately locating the diamond in the line of contact between the wheel and a finished piece of work, and means for reciprocating the diamond across the face of the wheel, whereby the wheel face may be trued and maintained in the same operative position relative to the work and resetting of the stop thereafter is not required for grinding duplicate pieces of work.

Grinding machine. MAXWELL I. MATHEWSON. U. S. 1,790,550, Jan. 27, 1931. A grinding machine having, in combination, a reciprocating table for supporting the work, a table drive, a reversing mechanism for controlling the reciprocation of the table from the table drive, mechanism for imparting a dwell in the movement of the table at each end of its reciprocating movement, and means for cushioning the movement of the table drive to move the table in an opposite direction.

Grinding machine. ALFRED J. BERG. U. S. 1,790,651, Feb. 3, 1931. In a machine for grinding valve seats having a motor, a motor support, and a spindle depending from the support, a bushing on the spindle adapted to allow the spindle to slide freely therein and adapted to be inserted in the valve-stem guide of the valve to be ground, the bushing comprising a cylindrical body portion smaller in diameter than the valve-stem guide, and having an exterior conical portion near the top for engaging the top of the valve-stem guide, and an expansible collar near the bottom for engaging the walls of the valve-stem guide.

Feed mechanism for bar and tube grinding machines. ARTHUR J. KOON. U. S. 1,790,668, Feb. 3, 1931. In a feed mechanism for bar and tube grinding machines, the combination of an upright frame, a pair of opposed roller carriers swiveled on the frame in axial alignment with each other, a third roller carrier swiveled on the frame on an axis at right angles to the axes of the pair of roller carriers, work-engaging rollers journaled on the inner ends of the carriers, a spring urging one of the opposed carriers toward the work, means for locking all of the carriers against turning with their rollers set at any predetermined angle to the axis of the work, a drive shaft, and transmission gearing therefrom to the rollers of the other opposed carrier and third carrier operative to drive the rollers in any angularly adjusted position of the last-named carriers.

Work rest for bar and tube grinding machines. ARTHUR J. KOON. U. S. 1,790,669, Feb. 3, 1931. In a work rest of the character described, the combination of an upright frame, a pair of opposed carriers swiveled on the frame in axial alignment with each other, a third carrier swiveled on the frame on an axis at right angles to the axes of the pair of carriers, work-engaging members mounted on the inner ends of the carriers,

and means for clamping the carriers with their work-engaging members set at any predetermined angle to the axis of the work passing between them.

Grinding machine. JOHN E. CASTER. U. S. 1,791,442, Feb. 3, 1931. A grinding machine including opposed grinding and regulating wheels, a work support projecting into the throat between the wheels, means for producing relative movement of the wheels to vary the width of the grinding throat and means for limiting the approach of the axes of the work and the grinding wheel.

Cam-grinding apparatus. HERBERT A. SILVEN. U. S. 1,791,479, Feb. 3, 1931. A cam-grinding apparatus comprising a grinding wheel and a cam-blank support which are relatively movable toward and from each other, means including master cams to cause the relative movement to produce desired contours on various cam blanks, means to cause relative traversing movement between the wheel and cam blanks to position the wheel in operative relation with a given cam blank, and means to separate the wheel and the cam-blank support before a new cam may be located in position opposite to the wheel.

Grinding piston rings. MUSKEGON PISTON RING CO. AND G. W. OLSON. Brit. 337,949, Dec. 31, 1930. Apparatus for grinding piston rings and similar circular parts, adapted also for use with an existing grinding machine, consists of a bed upon which is slidable to and from the grinding wheel by means of a toggle operated by a handle, a carriage having thereon a fixed center and a center movable by rack gearing operated by a handle.

Grinding talking-machine needles, etc. H. ROBECK AND W. TUCHMANN. Brit. 338,058, Dec. 31, 1930. A machine for pointing needles for talking machines, etc., consists of a slowly rotating disk. The grinding wheel, which is of conical form, is supported by an arm pivoted to the frame of the machine, and angularly adjustable.

Swing grinding machines. PNEULEC, LTD., P. PRITCHARD, AND W. J. COOPER. Brit. 338,376, Jan. 7, 1931. A swing grinding machine suspended from links and moved over the work by handles on a hood surrounding the grinding wheel; an electric motor which drives the spindle through chain gearing enclosed in an oil-tight casing provided with a detachable sump.

Grinding rollers. O. WALDRICH. Brit. 339,168, Jan. 21, 1931. A machine for grinding rollers with a convex or concave longitudinal surface consists of a slide traversed along the work on the machine bed and having pivoted thereto a grinding head carrying a grinding wheel. The wheel is rocked about the pivot toward and from the axis of the work by a bar upon which rests a bearing, the bar being pivoted and rocked by a cam. A number of cams, or a cam drum of varying profile may be employed, the bar being adjusted along its pivot to engage the required cam.

Art and Archaeology

Standardization of colors. WILHELM OSTWALD. *Z. angew. Chem.*, **42**, 437–39 (1929).—A discussion of the classifications of others and that of O. See also *C. A.*, **16**, 1903. (*C.A.*)

Device for decorating. ANON. *Ceram. Age*, **16** [2], 105 (1930); for abstract see *Ceram. Abs.*, **9** [12], 1074 (1930). R.G.M.

Decorative possibilities of glass. ROGER W. SHERMAN. *Good Furniture & Dec.*, pp. 227–34 (Nov., 1930).—Glass is discussed in three divisions: structural, utilitarian, and ornamental. Illustrated. (*D.I.*)

Mosaic and glass painting. ANON. *Die Form*, pp. 565–70 (Nov., 1930).—Examples of work in churches, business houses, and public squares are given. (*D.I.*)

New designs for glass containers. ANON. *Canner*, p. 36 (Dec., 1930).—The present tendency in glass designs is toward shapes with many corners and angles. Mold costs are a serious consideration for the manufacturer. (*D.I.*)

New designs in bottles. PAULINE ARNOLD. *Printers' Ink Monthly*, pp. 44–46 (Sept., 1930). (*D.I.*)

Glassmaking as a fine art. HELEN SPRACKLING. *Country Life*, pp. 45–46 (Nov., 1930).—S. discusses modern developments in table glass. (*D.I.*)

Jacobite seals. FRANCIS BUCKLEY. *Connoisseur*, **84**, 242–44 (1929).—Glass seals, being cheaper and more reproducible than stone, were used as propaganda for the Jacobite cause. They belong mostly to the period after the Rising of 1745. Nineteen of these seals are illustrated, and 26 more described. H.H.S.

Fine old English glasses: X. Bonett glasses. XI. Glass tea caddies. XII. Glass ink-pots. FRANCIS BUCKLEY. *Glass*, **7** [12], 490–92 (1930). H.W.A.

Modern table service. ANON. *Creative Art*, pp. 365–67 (Nov., 1930).—Since the 18th Century, Wedgwood has become famous by his success in working on the composition of clay and obtaining a graduated scale of grains and colors. The renewal of studies along these lines and the greater importance attributed to the materials of which table pottery is made seem to be the most interesting characteristics of present day tendencies. (*D.I.*)

New French ceramics. G. M. GOLDMAN. *Ceram. Age*, **16** [3], 164 (1930).—Ceramic materials have been found to lend themselves especially well to a service which was supplied heretofore almost entirely to bronze or wood and they are being used for book-ends, lamps, trays, etc. See also *Ceram. Abs.*, **10** [3], 205 (1931). A.E.R.W.

New pottery. ELLEN D. WANGNER. *Small Home*, pp. 14–15 (Jan., 1931).—Illustrations and prices are given to show that attractive color in tableware may be had at small cost. (*D.I.*)

Eastern pottery. F. K. HANSON. *Design*, **32** [2], 40–42 (1930).—With our American tendency to multiply a salable commodity, we need artists to uphold ideals for formation of public taste. While Persia and China earn their fame by colorful glazing applied to finished form and pattern, Korea captivates by simple shapes and restrained decoration and glazes. E.B.H.

New ceramics at Cleveland museum. ANON. *Ceram. Age*, **16** [2], 93 (1930).—The Cleveland Museum of Art recently has added three vases to its collection of Greek ceramics: (1) a little pitcher bearing a primitive picture of Europa riding the bull, (2) a jar with two handles, bearing excellent warrior pictures which have escaped unharmed for 2500 years, and (3) a handsome mixing bowl of extraordinary quality, and of rather large dimensions. R.G.M.

Persian pottery and glassware. ANON. *Pottery Gaz.*, **56** [643], 95 (1931); *Studio*, **97** [403], 33–36 (1930).—An exhibition of Persian Art is to be held at Burlington House, London. Some fine specimens of Persian glassware and pottery are included in the exhibit. Illustrated. E.J.V.

History of the willow pattern. ANON. *Ceram. Age*, **16** [4], 223 (1930).—The willow pattern on china is a somewhat careless English adaptation of the Chinese and has been manufactured for a century and a half. There are various renderings of the pattern but the essential features are a pagoda and a fence at the right, a willow tree at the left overhanging a bridge on which usually three figures appear, with a boat above, a cottage on an island, and a pair of doves. About 1780 Thomas Turner, in charge of the pottery at Caughley, in Shropshire, introduced the first English willow pattern drawn for him after the Chinese original by Thomas Minton, who later became a famous potter himself. It was printed in blue under the glaze and was introduced for

table services in both porcelain and earthenware. It became so popular that it was copied with minor changes by Spode, Wedgwood, Minton, Adams, Clews, Davenport, and other potters. About 1830 the willow pattern was revived by the Staffordshire potters, who produced it in quantity in what is known as late Staffordshire. In 1900 the pattern was again revived by American manufacturers. The quasi Oriental legend which the picture illustrates is now so old as to be classed as folklore. A composite version is presented which suggests the romance which has gathered about this old pattern. R.G.M.

Modern archaeology. HORACE H. F. JAYNE. *Sci. Amer.*, **141,** 492–93 (1929).—Excavations are only a small part of an archaeologist's responsibilities. He must have theoretical and practical knowledge before he begins to dig and he must know how to preserve and restore his discoveries. H.H.S.

Art of the Persians. ANON. *Ceram. Age*, **16** [4], 239 (1930); *Illus. London News*, **177,** 815 (1930).—A brief description is presented of the art of the Persians. Several well-known pieces are described, among them the Rhages Bowl, commonly known as the King and Queen's Bowl recently destroyed. Illustrated. R.G.M.

Light on Ancient Greece. H. PAYNE. *Illus. London News*, **177,** 868–69 (1930); for abstract see *Ceram. Abs.*, **10** [1], 14 (1931). H.H.S.

Excavations at Petra and Edom. G. HORSFIELD AND AGNES CONWAY. *Geog. Jour.*, **76,** 369–90 (1930).—An illustrated account is given of the Henry Mond expedition to a region in which Captain Kitchener made explorations in 1883. H.H.S.

Pre-Inca discovery in Peru. A. H. VERRILL. *Illus. London News*, **176,** 248–49 (1930).—A civilization entirely unlike anything hitherto known in America has been found in the Nasca area. The ruins of Tiahuanaco are said to be 13,000 years of age, in which case S. America has the oldest city in the world. See also *Ceram. Abs.*, 9 [6], 407 (1930). H.H.S.

House decoration in ancient Rome. FRANCESCO FORNARI. *Illus. London News*, **176,** 290–91 (1930).—A Roman house with remarkable mosaics, frescoes, and wall graffiti has been found in the excavations beneath the early Christian Church of St. Sebastian, near Rome. Seven photographs. H.H.S.

Nelson relics. E. NEVILL JACKSON. *Connoisseur*, **84,** 282–89 (1929).—The illustrations include Staffordshire jugs and busts. H.H.S.

Wedgwood and 18th Century classicism. FRANK DAVIS. *Illus. London News*, **176,** 306 (1930).—The influence on Wedgwood ware of Sir William Hamilton's collection of Greek vases formerly belonging to the Porcinari family is traced. Six photographs. H.H.S.

Worcester porcelain works reorganized. ANON. *Ceram. Age*, **16** [3], 140–41 (1930).—A brief history of this celebrated English plant is presented with an account of its organization. R.G.M.

Kitchen decoration as a selling point. BERTHA ANNE HOUCK. *Amer. Bldg. Assn. News*, p. 656 (Nov., 1930). (*D.I.*)

Modern bathtubs. JAMES E. FOSTER. *Small Home*, pp. 24–26 (Nov., 1930).—Twenty examples of built-in tubs are described and illustrated. (*D.I.*)

Report on the competition of industrial designs, 1930. ANON. *Jour. Roy. Soc. Arts*, pp. 1003–1004 (Aug., 1930); pp. 1150–72 (Oct., 1930).—This report tabulates number of competitors, names of winners, and amounts of awards. Illustrated. (*D.I.*)

Art schools and industry. ANON. *Brit. Printer*, pp. 116–20 (Sept.-Oct., 1930).—Industrial art schools in Germany are discussed. (*D.I.*)

Romantic revival of 1930. FRANCIS HENRY TAYLOR. *Parnassus*, pp. 3–7 (Oct., 1930).—T. comments on the subject of art in America. (*D.I.*)

Place of the American designer. LAWRENCE M. BAYAN. *Mfg. Jeweler*, p. 28 (Oct., 1930).—B. asserts that standardized mass production must assume some of the characteristics of individualistic design coupled with practical efficiency in production. (*D.I.*)

Designer-craftsman. RICHARD F. BACH. *Good Furniture & Dec.*, pp. 193–94 (Oct., 1930).—B. discusses the need for expert designers, their training, and experimental research. (*D.I.*)

Stylist in building materials. ALFRED E. FOUNTAIN, JR. *Advertising & Selling*, pp. 23–24 (July, 1930).—It is up to the manufacturer, with the help of the stylist, to produce new and different creations to meet the new and increasingly insistent demands. As commodities, the so-called staples such as brick, lumber, glass, and hardware have come to the point where it is impossible for either manufacturer, jobber, or dealer to make a profit from them. They must be redesigned to be made attractive specialties in order to make a profit for their producers. (*D.I.*)

Comfort, convenience, and color. I. B. GORHAM. *Creative Art*, pp. 249–53 (Oct., 1930).—Examples from the designs of Kem Weber are given. (*D.I.*)

Modern rooms. FRANCIS T. MILLER. *Country Life*, pp. 35–41 (Nov., 1930).—Illustrated. (*D.I.*)

Wohnhaus Stefan v. Auspitz-Wien. L. W. ROCHOWANSKI. *Deut. Kunst Dekoration*, pp. 51–58 (Oct., 1930).—The dwelling of Stefan v. Auspitz in Vienna is described. (*D.I.*)

BOOKS

Modern Decorative Art. MAURICE S. R. ADAMS. Lippincott, New York, 1930. 249 pp. Price $7.50. Illustrated. (*D.I.*)

Art and Industry. R. W. SCHMIDT. Boni, New York, 1930. Price about $2.50. S. describes the technical achievements of the ages. Illustrated. (*D.I.*)

National Museum of Wales: Guide to Collection of Welsh Bygones. IORWETH C. PEATE. National Museum of Wales, Cardiff, 1929. Price 1s 6d. Reviewed in *Connoisseur*, **84**, 257–58 (1929). H.H.S.

Diamond-engraved glasses of the 16th Century. WILFRED BUCKLEY. Ernest Benn, Ltd., London, 1929. Price 25s. Reviewed in *Connoisseur*, **84**, 318–19 (1929). H.H.S.

The Welf Treasure. (German.) OTTO VON FALKE, R. SCHMIDT, AND G. SCHWARZENSKI. Frankfurt Verlag, Frankfurt a.M., and Bumpus & Co., London, 1930. Price £11. Reviewed in *Times Lit. Supp.*, **29**, 901 (1930).—A sumptuous volume on the extraordinary collection of enamels, gold, and precious stones which was the pride of Brunswick cathedral, is now exiled but not yet dispersed. H.H.S.

Attic Black-Figure. J. D. BEAZLEY. Humphrey Milford, Oxford Univ. Press, 1929. Price 7s 6d. Reviewed in *Connoisseur*, **84**, 258 (1929).—An account is given of some of the more important features of Attic Black-Figure pottery between the 7th and 5th Centuries B.C., showing the similarity of type with the Red-Figure that followed nearer the 3rd Century B.C. H.H.S.

Excavations on the Temple of Nabu at Nineveh. R. C. THOMPSON AND R. W. HUTCHINSON. 251 pp. Society of Antiquaries, London, 1930. Price 12s 6d. Reviewed in *Times Lit. Supp.*, **29**, 943 (1930).—An account is given of the British Museum exploration of 1927–28. The pottery, beads, shells, etc., found are discussed by Hutchinson, Beck, and others. H.H.S.

PATENTS

Design for plate, etc. HENRY A. PICKARD. U. S. 83,059, Jan. 13, 1931; EDWIN C. TAYLOR. U. S. 83,219, Feb. 3, 1931.

Design for tumbler, etc. BANKS D. BROWN. U. S. 83,030, Jan. 13, 1931; JAMES M. PAYNE, JR. U. S. 83,171, Jan. 27, 1931.

Cement, Lime, and Plaster

Studies on calcium ferrites and iron cements. I. S. NAGAI AND K. ASAOKA. *Jour. Soc. Chem. Ind.* [Japan], **33** [4], 130–33*B* (1930).—The ferrite of the highest lime content was found to be $2CaO \cdot Fe_2O_3$ and not $3CaO \cdot Fe_2O_3$. Therefore, the factor 0.70 of $2CaO \cdot Fe_2O_3$ is correct. The different combinations formed by iron oxide and lime in the high-lime mixtures $3(CaO):1Fe_2O_3$, $5(CaO):1(Fe_2O_3)$ were studied in the following manner: (1) The mixture $3(CaO):1(Fe_2O_3)$ was heated to various temperatures above 900°C and the product examined for specific gravity, free lime, soluble and insoluble residues to 0.5 normal HCl, molar ratio of combined lime to combined ferric oxide, and total per cent of dicalcium ferrite. Values found are tabulated. By a comparison of results, the combination between ferric oxide and lime was explained. Dicalcium ferrite $2CaO \cdot Fe_2O_3$ dissolves easily in 0.5 HCl, but monocalcium ferrite $CaO \cdot Fe_2O_3$ remains in the insoluble part. Therefore, the molar ratio of combined lime to ferric oxide was smaller than that of theoretical value in the products heated to 1100°C and 1200°C owing to the forming of $CaO \cdot Fe_2O_3$ and remaining in the insoluble part. This ferrite disappeared in the products heated above 1300° and changed completely into $2CaO \cdot Fe_2O_3$. This was shown by the value of the molar ratio of combined lime to combined ferric oxide. The difference of solubility of $2CaO \cdot Fe_2O_3$ and $CaO \cdot Fe_2O_3$ in 0.5 normal HCl will be applied to the separation of the two ferrites in the following discussions. (2) The mixture of $5(CaO):1(Fe_2O_3)$ was heated in the manner described above and similar tests made. The results are tabulated and show that the dicalcium ferrite $2CaO \cdot Fe_2O_3$ is easily formed by heating the mixture above 1200°. The mixture $3CaO \cdot Fe_2O_3$ or other calcium ferrite of higher lime content than $2CaO \cdot Fe_2O_3$ does not produce the high-lime mixtures as $5CaO:Fe_2O_3$ or $3CaO:Fe_2O_3$ even by heating to 1400 to 1540°C or above. (3) The mixture $2(CaO):1(Fe_2O_3)$ of just forming $2CaO \cdot Fe_2O_3$ was investigated in the manner described above and the values found given in a table. **II.** *Ibid.*, **33** [5], 161–64*B* (1930).—Data on the following studies are given: (1) Extraction of free lime by the anhydrous glycerine alcoholic solution of ammonium acetate and preparation of pure $2CaO \cdot Fe_2O_3$ from the mixture $3(CaO):1(Fe_2O_3)$ heated to 1350°C and 1550°C. Conclusion: $2CaO \cdot Fe_2O_3$ is the ferrite of highest lime content even when the mixture rich in lime is heated to melting. (2) Heating tests on the mixture $1(CaO):1(Fe_2O_3)$. Conclusion: The combining of the two substances to form monocalcium ferrite $CaO \cdot Fe_2O_3$ begins at about 1000°C and proceeds slowly to 1150°, but ends at 1200°C by melting to a black mass. (3) Solubility of monocalcium ferrite $CaO \cdot Fe_2O_3$ in hydrochloric acid. (4) Separation of $2CaO \cdot Fe_2O_3$ and $CaO \cdot Fe_2O_3$ from mixtures of the two ferrites by hydrochloric acid of different concentrations. Conclusions: These two calcium ferrites can be separated by treating with different concentrations of HCl. Monocalcium ferrite $CaO \cdot Fe_2O_3$ is produced first and then changes to dicalcium ferrite $2CaO \cdot Fe_2O_3$ in the case of the high-lime mixture. **III and IV.** *Ibid.*, **33** [6], 190–92*B*; [7], 256–59*B* (1930); *Tonind.-Ztg.*, **54** [99], 1548 (1930).—Ground samples of $CaO \cdot Fe_2O_3$ and $2CaO \cdot Fe_2O_3$ were treated with distilled water. After 7 and 28 days they were filtered and the filtrate analyzed for slaked lime and iron oxide. It was found that monocalcium ferrite does not react with water but $2CaO \cdot Fe_2O_3$ hydrates and the precipitated calcium hydroxide dissolves in water. It was also found in determining the solidities of 1:3 mortars, that $CaO \cdot Fe_2O_3$ was nonhydraulic, while $2CaO \cdot Fe_2O_3$ hydrates and its strength depends on the hardening of calcium hydroxide, explaining the considerable loss in solidity with

water storage. Samples tested for volume stability by the methods of Bauschinger and LeChatelier showed expansions for $2CaO \cdot Fe_2O_3$ which is in conformity with tests previously made. Investigations of the three substance system SiO_2–Fe_2O_3–CaO by joint heating of the constituents to temperatures up to 1500° showed that first calcium ferrite combined and then the separate lime silicates up to trisilicate were formed; this was clearly shown in the increase in the molar ratio of CaO/SiO_2. The four substance system SiO_2–Al_2O_3–Fe_2O_3–CaO was investigated in the same way. During heating tests CaO and Fe_2O_3 combined and formed $2CaO \cdot Fe_2O_3$, CaO and Al_2O_3 formed $3CaO \cdot Al_2O_3$, and CaO and SiO_2 formed $2CaO \cdot SiO_2$ and $3CaO \cdot SiO_2$. It was again found that CaO and SiO_2 combine easily into $3CaO \cdot SiO_2$ only when ferrites or aluminates are present. **V.** *Jour. Soc. Chem. Ind.* [Japan], **33** [8], 312–15*B* (1930); *Tonind.-Ztg.*, **54** [95], 1491 (1930).—By heating mixtures prepared from pure and natural materials, it was determined that the chemical combination of a raw mixture consisting of about 23 parts SiO_2, 2.5 parts Al_2O_3, 9 parts Fe_2O_3, and 116 parts $CaCO_3$ first takes place between 1450 to 1500°, which are higher sintering temperatures than those for Portland cement and Kühl cement. The quantities of silicates, aluminates, and ferrites present were calculated and are tabulated. By testing the solidities and comparing them with those of Portland cement and Kühl cement, it was found that the solidities of iron cements were the lowest because of a high $2CaO \cdot Fe_2O_3$ content and low $3CaO \cdot SiO_2$ content. Volume stability tests made by the methods of LeChatelier and Bauschinger showed that iron cement had a good volume stability. The higher sintering point of iron cement depends on the low alumina content and the lack of the eutectic "celite." M.V.K.

Lime-alumina cement. II. S. NAGAI. *Jour. Soc. Chem. Ind.* [Japan], **33** [6], 196–98 (1930).—Large quantities of ferric oxide in lime-alumina cements prevent the dusting of clinker and decrease the deterioration of strength of mortars on water curing, but the absolute strength is smaller than that of high-aluminous cements. By mixing 0.5 to 1% borax to the raw mixture, the clinker did not disintegrate and melted at a temperature 10° lower; dusting disappeared entirely. The compressive strength of lime-alumina mortars decreased in water curing because of the dissolution of the hydrated product of calcium aluminates; this is a characteristic defect of lime-alumina cements. For Part I see *Ceram. Abs.*, **9** [11], 912 (1930). M.V.K.

Electrically-fused alumina cement. M. KAUTSCHISCHWILI. *Tonind.-Ztg.*, **54** [101], 1565–67; [102–103], 1585–86 (1930).—Advantages of alumina cement over Portland cement are (1) solidity from the beginning of setting, (2) resistance to chemicals, (3) setting below freezing, (4) favorable setting time, and (5) absolute volume stability. K. describes the cement plant in Tschischkowitz for the production of alumina cement where bauxite and fired lime are fused in electric furnaces working on the luminous arc principle. The production of alumina-fused cements is 60 tons per day in this plant. M.V.K.

High-quality cements. KARL A. GOSLICH. *Tonind-Ztg.*, **55** [4], 48–51 (1931).—G. explains what is meant by "high-quality cements" which are obtained by careful preparation of raw materials, firing, and sintering, and describes tests with different cements. It was found that cements having either a very high or very low silicic acid content possess high solidities. In the former cements, tricalcium silicates which produce this high solidity are formed in large quantities. The raw paste of such cement requires very fine grinding and an intense firing. Cements poor in silicic acid suggested by H. Kühl have a high content of alumina; their high iron-oxide content prevents quick setting. They are fused at lower temperatures and are not so finely ground. Different admixtures are used to promote the sintering of the raw paste such as iron oxide, fluorspar, calcium chloride, and gypsum. Kühl found that calcium

bromide is the most efficient admixture but it is too expensive to be used in industry. Alumina cements have a special place among cements as they are not mentioned in German standard specifications for cements. They differ from Portland, iron Portland, and blast-furnace cements in their chemical composition, and contain from 35 to 45% alumina and 29 to 45% lime, while Portland cement contains from 5 to 8% alumina only. Their sintering and fusing temperatures lie very close together. The quick setting of alumina cements depends on the combination of lime with alumina to form calcium aluminates. Its use is limited in Germany because of its high price and the necessity of importing the raw material, bauxite, from abroad. M.V.K.

Producing uniformity in cement. MARCEL BERNASCONI. *Rock Prod.*, **33** [20], 89 (1930); for abstract see *Ceram. Abs.*, **9** [10], 823 (1930). W.W.M.

Effect of magnesium oxide on clinker and cement. ALTON J. BLANK. *Concrete*, **37** [2], 85–87 (1930); for abstract see *Ceram. Abs.*, **10** [3], 171 (1931). H.W.A.

Chemistry of Portland cement manufacture. I. Effect of silica. ALTON J. BLANK. *Concrete*, **37** [3], 85–87 (1930).—The fineness of grain has a direct bearing on the reaction of the silica with lime and upon the temperature for proper combination. A series of tests resulted in the following conclusions (other things being equal): (1) Highly-siliceous raw mixtures are hard to clinker, requiring a maximum of fuel for a minimum of output, and, unless finely ground, combine with difficulty in the kiln, resulting in cements containing high insoluble residues. (2) Siliceous raw mixtures containing their silica in the soluble form combine more readily in the kiln than those containing the same percentage of insoluble silica. (3) Siliceous clinker is uniformly small in size. (4) High-silica cements are of a slow-setting and hardening nature, usually sound, and the more siliceous the cement is, the more resistant it is to all kinds of influences. They yield strengths slightly below normal at ages up to seven days, but show good increase in strength thereafter. H.W.A.

High iron-oxide Portland cements. III. S. NAGAI AND K. AKIYAMA. *Jour. Soc. Chem. Ind.* [Japan], **33** [4], 137–40 (1930).—The first raw mixture was composed of 100 weight parts Koganei Jodo colloidal earth, 100 copper slag, and 446 limestone and had a chemical composition (calcined) SiO_2 18.06%, Al_2O_3 8.87%, Fe_2O_3 9.06%, CaO 64.0%. This mixture was sintered at 1320 to 1350° and the clinker ground with 3% gypsum in a porcelain pot mill. The compressive strength of samples of 1:3 mortar after 7 days was 108.2, after 28 days, 165.3, and after 28 days combined, 182.6. Similar tests were made on other samples of high iron Portland cements made from raw mixtures containing pure chemicals, silica, alumina, ferric oxide, and calcium carbonate. Results are tabulated. For Part II see *Ceram. Abs.*, **9** [10], 824 (1930). M.V.K.

Calculation of heat flow in rotary cement kilns. H. BUSSMEYER. *Zement*, **19** [22], 522–24 (1930); *Rock Prod.*, **33** [20], 89 (1930).—B. criticizes A. B. Helbig (see *Ceram. Abs.*, **9** [11], 964 (1930)) for statements made in calculating the heat flow of the new G. Polysius rotary kiln. W.W.M.

Multistage process for firing Portland cement clinker. ROBERT D. PIKE. *Rock Prod.*, **33** [4], 65–69 (1930); see also *Ceram. Abs.*, **9** [10], 826 (1930). W.W.M.

Drying gypsum plaster molds and cases. R. B. LADOO. *Fuels & Fur.*, **8** [7], 985–86 (1930).—(1) The mold should be dried from the back, *i.e.*, so that evaporation takes place on the back or outer surface, rather than from the surface used to form the ware. (2) Temperature of the drying room should be regulated so that it is uniform within a few degrees over the whole room and so that the molds need not be placed too close to the source of heat. Mold drying temperature must be carefully regulated or molds will be "burned." A.E.R.W.

Effect of mixing water on strength of mortar. E. PROBST AND K. E. DORSCH. *Zement*, **19** [43], 1009–11 (1930); *Pit & Quarry*, **21** [6], 67 (1930).—It has been known

that there is a great difference in strengths of mortars and time of set in testing cement in different laboratories. This article reports on a study of the chemical analyses of the water available in the city systems in twenty large German cities. The effect of electrolytes such as $CaCl_2$, $CaSO_4$, $MgCl_2$, and NaCl on the strength and the setting time are well known from previous investigations. E.P.R.

Hydrocal: an improved plaster. W. M. MYERS AND G. T. MORSE. *Ceram. Age*, **16** [6], 324–25 (1930).—Paper presented at Autumn meeting of the New Jersey Clay Workers Assn. Hydrocal is a white, finely-ground material produced from gypsum and is similar in appearance to pottery plaster. It differs from the latter in the following respects: (1) its consistency is low, and (2) its tensile and compressive strengths are much greater than any ordinary pottery plaster. The compressive strength of Hydrocal increases with a decrease in consistency, or the amount of mixing water used. It is 4 to 20 times harder than ordinary plaster and its resistance to abrasive wear is correspondingly increased. Absorption is much less than for any pottery plaster. Hydrocal has been used most satisfactorily for case molds and for hot-press molds in the manufacture of electrical porcelain. A.E.R.W.

Evolution of German standard specification for cement. K. A. GOSLICH. *Tonind.-Ztg.*, **55** [11], 4–7 (1931).—G. gives a historical review of the evolution of German standard specifications for cement and points out the higher requirements and the rising standards for qualities. M.V.K.

PATENTS

Treatment of phosphate rock and alunite. HERBERT H. MEYERS. U. S. 1,791,103, Feb. 3, 1931. The process of making relatively high-alumina comparatively quick-hardening cement, consisting in calcining a mixture of finely-ground phosphate rock and finely-divided alunite, treating such calcined product with ammonia, water, and carbon dioxide, separating the solid residue from the solution, and calcining such separated residue according to the practice of making aluminate cements to produce a cement of the high-alumina quick-hardening type.

Cements and mortars. W. REISMANN, R. H. SCHLOSS, AND W. H. EVERS. Brit. 338,664, Jan. 14, 1931. A cement for use as a binder in hydraulic mortar comprises 50 parts by weight of water glass of 25° Bé and 100 parts of a mixture of finely-ground slag and burned magnesite in which the slag predominates. In an example the slag and magnesite mixture comprises 92 parts of slag and 8 parts of magnesite. A mortar may be made by adding one part by weight of the slag and magnesite mixture to three parts of fine aggregate, *e.g.*, sand, and gaging with the water-glass solution.

Enamels

Use of nepheline for enamels. A. I. ZHILIN. *Ceramics & Glass*, **6** [10], 485–88 (1930).—Z. describes investigations made to determine the possibilities of using in enamels the nepheline found in large deposits in the Ural mountains. The results show that nepheline can be used with success instead of feldspar in ground or white enamels. See also *Ceram. Abs.*, **10** [2], 143 (1931). M.V.K.

Controlling the fineness of the enamel ground. ANON. *Emaillewaren-Ind.*, **7** [52], 73–74 (1930).—The necessity of controlling the fineness of an enamel ground is discussed, as the size of the grain influences greatly the opacity, luster, and method of treating. M.V.K.

Testing the coat thickness of an enamel. LOUIS VIELHABER. *Emaillewaren-Ind.*, **7** [52], 409–11 (1930).—A reliable method must be found for testing the thickness of the enamel layer because of its influence on quality. An increase in thickness does not produce corresponding increase in opacity. Testing methods are discussed. M.V.K.

Enameling objects of sheet iron. JULIAN BORDEGE. *Quim. Ind.*, **6**, 243–47 (1929).—All articles should be given a preliminary ignition (*a*) to remove organic matter and (*b*) to remove surface oxide. Removal of organic matter by heat is uneconomical because the resulting oxide requires additional acid for its removal. The principal object of ignition is to remove surface oxide owing to differences in coefficient of expansion of sheet and oxide and also to form an oxide or to convert surface oxide into a form insoluble in pickling, *i.e.*, 750 to 800°. The sheet is first washed with dilute HCl or spent pickle. The steel grid supporting the objects is preferably of C 1.6, Mo 0.3, Si 1.6, Cu 20, and Ni 0.5%. The pickling acid is made from 10 parts of 65 to 66 Bé H_2SO_4 diluted with 90 H_2O or 20 to 22° Bé HCl diluted with 2 parts of H_2O. Although H_2SO_4 is cheaper than HCl, the former has to be heated, so that the latter, which acts rapidly at ordinary temperature, is better. B. recommends 1 part 22° Bé HCl + 2 parts H_2O + 120–140 g./10 liter of solution. This mixture cannot be used to revivify old liquors. Fresh pickle is preferably activated with some old pickle, the H retained in the latter acting catalytically. A rapid method is given for determining free acid in the bath. The article should stay in the acid bath 25 to 35 min., insufficient pickling being very deleterious. The pickling cage should have a slight movement to homogenize the liquids and to avoid polarization; 40% failures may occur without the movement. The acid container is preferably of lava. The method of bath construction is given. The sheets should be washed in changes of water, but not exceeding 24 hr., followed by a wash in 0.5 to 2% Na_2CO_3 varying with the alkaline bath temperature. (*C.A.*)

Influence of superheating molten cast iron. J. E. HURST. *Foundry Trade Jour.*, **43** [744], 351 (1930).—Certain slight changes in properties have been brought about by superheating. The tensile strength, stiffness as indicated by the modulus of elasticity, and Brinell hardness are slightly higher in the superheated material. The permanent set value and the stress/deflection value of the superheated material are lower than the normal material. The superheated material is liable to extensive unsoundness. H.W.A.

Creep limit of cast steel at elevated temperatures. ANON. *Foundry Trade Jour.*, **43** [743], 335–36 (1930).—For the determination of creep, three methods were adopted: (1) experiments with constant rate of loading at constant temperature, (2) experiments with constant load and varying temperature, and (3) experiments with constant load and constant temperature. Descriptions of each test and results obtained are given. H.W.A.

Some interrelationships in gray iron metallurgy. J. W. BOLTON. *Foundry Trade Jour.*, **40**, 449–54 (1929).—The correlation of test results to engineering properties of cast-iron castings is discussed, and numerous curves are plotted showing the effects of various factors on strength, the relationship of the volume-area ratio to cooling rates, etc. A classification of cast irons based on C and Si contents is given. The raw materials in the charge, melting practice, and thermal and mechanical treatment are also important factors influencing the properties of cast iron. The rate of cooling is very important and is controlled by various factors, especially the volume to surface ratio of the casting. Results of tests on different-sized castings of one grade of cast-iron are given in detail. Examples are given showing how the strengths of commercial castings can be calculated from test-bar results by allowing for the influence of the various factors discussed above. Test-bars should have similar cooling rates to those of the castings represented. The Fremont shear test on small specimens cut from castings is not generally reliable. The form and amount of graphite are most important. Dissolved gases in cast iron do not have serious effects. (*C.A.*)

Continuous-electric enameling furnace. ANON. *Fuels & Fur.*, **8** [12], 1683–84

(1930).—Temperature control in the furnace described is entirely automatic. The apparatus requires only one unskilled operator for one to three furnaces, the power consumption is low, and rejects are reduced to a minimum. A.E.R.W.

Muffle-type enameling furnace equipped with recuperator. ANON. *Fuels & Fur.*, **8** [10], 1425–26 (1930).—A description of an enameling furnace equipped with a recuperator is given. It is stated that crazing has been practically eliminated and that the economy of the installation has been increased since the recuperator was added to the furnace. A.E.R.W.

Gas-fired semi-automatic vitreous enameler. J. B. NEALEY. *Ceram. Age*, **16** [4], 212–14 (1930).—A description is given of a new continuous and automatic enameling furnace installed recently by the Detroit-Michigan Stove Co. The ground coat is applied and fired at night and the white coats during the day. The furnace is a muffle type, gas heated, and controlled automatically by thermocouples in the furnace wired to an automatic temperature control. A.E.R.W.

Effect of furnace gases on quality of enamels for sheet steels. A. I. ANDREWS AND E. A. HERTZELL. Univ. of Ill., Eng. Expt. Sta., *Bull.*, No. 214, pp. 1–29 (1930); see also *Ceram. Abs.*, **9** [9], 714 (1930). A.E.R.W.

Foundry practice. R. H. PALMER. *Refrac. Jour.*, **5** [58], 365 (1930); see also *Ceram. Abs.*, **9** [11], 997 (1930). E.P.R.

Study of slip lines, strain lines, and cracks in metals under repeated stress. H. F. MOORE AND TIBOR VER. Univ. of Ill., Eng. Expt. Sta., *Bull.*, No. 208, pp. 1–60 (1930).—A number of conclusions were drawn as follows: (1) Fatigue-damaged portions of Armco iron and 0.20 carbon steel showed a greater Rockwell "B" hardness than undamaged portions. (2) Slip tended to take place in the direction of maximum shearing stress. (3) Cracks tended to follow the direction of previously formed slip lines or to appear in the direction of subsequent slip lines. For Armco iron and 0.20 carbon steel, abundant slip lines preceded fatigue cracks. (4) Undamaged portions of 0.20 carbon steel showed abundant Hartmann (or Leuders) lines under plastic stretch; fatigue-damaged portions did not. Such lines occur most easily on annealed specimens. (5) Fatigue damage is due to fragmentation of grains into laminae by slip and not to "crystallization" or recrystallization. Many micrographs are shown. A.E.R.W.

Decalcomania as applied to porcelain enameled products. II. G. HARRY FRANK. *Better Enameling*, **1** [8], 25–29 (1930).—The method of application of ceramic decals or transfers to vitreous enamel and the extremely complicated designs possible with this type of transfer are described. For Part I see *Ceram. Abs.*, **10** [1], 21 (1931). W.C.O.W.

History of enameling. JENET. *Emaillewaren-Ind.*, **7** [52], 75–76 (1930).—The first book on enameling was written by Moritz Vogelgesang in 1851 in Braunschweig. Methods and preparations of enamels described are of great interest even now. Enameling was done only on the interior of casts. The outside usually was tarred. The composition of ground-fritted enamels was the same as at present. The white enamels differed in that they contained up to 37% tin oxide. M.V.K.

BOOK

Manufacture of Steel Sheets. EDWARD S. LAWRENCE. Penton Publishing Co., Cleveland, Ohio. 233 pp. Price $6.15. Reviewed in *Mining & Met.*, **12** [290], 20 (1931).—The sequence of operations in sheetmaking from the manufacture of the steel to the finished sheet, with special reference to the production of high-grade sheets for automobile bodies, is described. The influence of various methods upon the quality of the product and the causes and prevention of defects are given. E.J.V.

PATENT

Making zirconium opacifier. CHARLES J. KINZIE. U. S. 1,789,311, Jan. 20, 1931. The method of making zirconium opacifiers for vitreous enamels containing sodium zirconium silicate and zirconium silicate which comprises heating a mixture of zirconium silicate, about 78 parts by weight, and sodium carbonate, about 22 parts by weight, to about 900 to 950°C, and cooling and disintegrating the resulting mass.

Glass

Physical properties of glasses in relation to their composition. Transparency of glass in the ultra-violet, visible, and infra-red range. M. FRITZSCHMIDT, G. GEHLHOFF, AND M. THOMAS. *Z. tech. Physik*, **11**, 289–326 (1930); *Vancoram Rev.*, **2** [1], 11 (1931).—A comprehensive study was made of the relation between composition and transparency of glass for various ranges of λ. The transmitted spectrum was determined in the ultra-violet by a quartz spectrograph, in the visible by a König-Martens spectrophotometer, and in the infra-red by a mirror spectrometer with thermocouple and galvanometer. Fifty-nine sets of curves are given of the spectrum as a function of the composition. The experiments included glasses of 82% SiO_2 + 18% Na_2O with replacement of SiO_2 by noncoloring oxides (MgO, CaO, ZnO, PbO, BaO, B_2O_3, Al_2O_3, As_2O_3, Sb_2O_3, ZrO_2, TiO_2) and coloring oxides (yellow CeO_2, U_3O_8, green Fe_2O_3, Cr_2O_3, V_2O_4, blue CuO, CoO, red Mn_2O_3, NiO): a second set of glasses had 80% (SiO_2 + alkali oxide) + 20% B_2O_3 or PbO with increasing amounts Li_2O, Na_2O, and K_2O; 4 component glasses were studied of 65% SiO_2, 15% (Na_2O + K_2O), 20% BaO. In the ultra-violet range quartz glass is not surpassed in transparency by any silicate glass. Good transparency can be obtained with alkalis, alkaline earths, ZnO, B_2O_3, and Al_2O_3; these components are without great influence on the absorption limits of the glass. If ultra-violet transparency is to be combined with absorption of visible light NiO and CoO additions are useful. Strict absence of Fe is required. Absorption of ultra-violet light is obtained in colorless glass with V, Ce, Ti, Pb, or Sb in decreasing order of activity. In the visible range the well-known absorption bands are found, varying in position with the composition of the glass base. In the infra-red, quartz glass is superior, being completely transparent down to 3.6μ, then decreasing to low values at 5μ with absorption bands at 3.3μ and 4.3μ. Except for the B_2O_3 glasses the other colorless ones are largely alike: highly transparent to 2.6μ, medium to 4μ, little at 5μ. Most basic oxides deepen the absorption bands at 2.9μ and 3.6μ or make them overlap (transparency maximum at 4μ). For boric acid glass strong bands are found from 2.8μ on, causing considerable absorption beyond 3.5μ. The literature on the subject is reviewed.

Scientific fusion of glass. F. FRANCESCHINI. *Ind. Silicati*, **8** [7], 7–8; [8], 7–9; [9], 9–11; [10], 7–10; [11], 7–10 (1930).—From a discussion of the work of Abbé and Schott and the manufacture of glass at Jena, F. proceeds to the methods of determining the physical properties of glasses and the maximum and minimum values for the physical constants of all glasses which can be manufactured under the present industrial conditions. Knowing these limits for every physical property of glass, one could fix the values of the physical constants for a certain glass within these limits and choose the appropriate chemical compositior for the glass. The glasses considered are mixtures which result from the fusion at temperatures above 900° of the components: mineral oxides (acids and bases), and salts, *e.g.*, potassium silicate, lead borate, and in rare cases other metals as gold, silver, platinum, copper, and metalloids as sulphur and carbon. The following data on the physical properties are given: (1) Specific

gravity: The specific gravity of a cubic centimeter of glass at ordinary temperatures varies between 2.2 and 6.3 g. according to the chemical composition. The lowest density is that of a glass composed of boric acid, silicic acid, potash, alumina, and fluorine; the maximum value is that of a lead silicate glass (82% PbO, 28% SiO_2). (2) Resistance to traction and pressure: (*A*) The resistance to traction is the force in kilograms necessary to break a 1 sq. mm. section when drawn. It varies between the values 3.3 and 8.1, the minimum value being that of the lead silicate glass referred to above, and the maximum is that of a silica zinc potassium glass. (*B*) Resistance to pressure is the force expressed in kg. by which a cube of glass placed between steel plates is crushed to powder. It varies between 60.6 and 126.4 kg./sq. mm. of surface. The lead silicate glass (82% PbO, 28% SiO_2) gave the minimum value and a boron silicate of sodium and aluminium gave the maximum value. (3) Coefficient of elasticity measured in kg. per sq. mm.: Minimum value 4800 (a glass composed of boron, alumina, soda, and baryta), maximum value 7970 (a borosilicate glass containing baryta, zinc oxide, and alumina). (4) Specific heat measured in gram calories at a mean temperature of 15°C: Minimum value 0.08 (lead silicate glass), maximum value 0.23 (a glass composed of a borate of aluminium and lithium). (5) Heat conductivity measured in gram calories, degrees centigrade per cm. per second. Minimum value 0.00108 (lead silicate glass), maximum value 0.00227 (a glass composed of borosilicate of soda and alumina). (6) Coefficient of expansion (between 0 and 100°C): Minimum value 0.0000110 (a zinc borate glass), maximum value 0.0000337 (a glass composed of an alkali silicate, zinc, and alumina). Mean refractive index (line D (yellow) of Fraunhofer). Refractive index of air = 1. Minimum 1.465 (a light borosilicate glass), maximum value 1.963 (a heavy flint or silicate of lead glass). (8) Mean dispersion (difference between the refraction of lines F (blue) and C (red) of Fraunhofer): Refractive index of air = 1. Minimum value 0.00708 (light crown glass), maximum value 0.04882 (heavy flint glass). (9) Relative refraction V: Index of refraction of air = 1. Minimum value 19.7 (heavy lead glass), maximum value 70.0 (a glass composed of phosphorus, barium, and aluminium). (10) Dielectric constant: Dielectric constant of air = 1. Minimum value 5.5 (a glass composed of boron, alumina, sodium, and barium), maximum value 9.1 (a sodium lead silicate glass which is a crown glass of high dispersion). M.V.K.

Artificial and natural solarization and stabilization of special ultra-violet transmitting glasses. DONALD C. STOCKBARGER AND LYMAN B. JOHNSON. *Jour. Frank. Inst.*, **210** [4], 455–59 (1930); *Amer. Glass Rev.*, **50** [2], 15–16 (1930).—Since the type of radiation determines the course of solarization, reliable solarization tests require use of radiation having the same effect on glass as has sunlight. A large number of tests were made on several brands of glass, comparing solarization by bare quartz mercury arc, filtered mercury arc, and solar radiation. Tests were also made on the rejuvenation by sunlight of glass oversolarized by the bare quartz mercury arc. Results, summarized in two tables, indicate that arc radiation filtered through neutral glass, the transmission of which terminates at about 3000 Å, is the closest to natural sunlight. The tests also support the fact that ultra-violet transmitting glasses are stable after solarization. M.A.E.

Opacification of glass by a blast lamp. M. A. BESBORODOV AND M. F. SHUR. *Ceramics & Glass*, **6** [10], 466–70 (1930).—The appearance of opacity in glass while it is being worked with a blast lamp is discussed and tests are described which are made to ascertain the dependence of the velocity of glass opacification on (1) the chemical composition of glass, (2) the kind of flame used, (3) the method of working the glass, and (4) the quantity of cullet used in the glass. Fifteen kinds of glass were treated with reduced and oxidized flames. The results of these tests are tabulated and show

that the velocity of opacity depends on the chemical composition of glass. Glass containing CaO and alkalis opacifies most rapidly; glass containing ZnO opacifies less rapidly. Glasses having a high content of Al_2O_3 and B_2O_3 opacify only with reduced flames. With oxidized and reduced blasted flames they do not opacify at all. The presence of MgO in glass seems to aid opacification. Glass containing Al_2O_3 (9.3%) does not opacify when worked with any kind of flame. Glass containing PbO opacifies more rapidly on a reduced flame than on an oxidized. A high quantity of silicic acid aids opacification. All glasses opacify more rapidly on a reduced flame than on an oxidized. This opacification of glass is a reaction taking place on the surface of glass through the building of new formations by the red-hot gas particles. Some formations have the character of crystals, others that of amorphous effloresences. The quantity of cullet does not influence the opacity of glass while it is being worked on a blast lamp. A series of other salt compounds besides NaCl were tested to find their influence on opacity of glass. KCl removes the opacity completely and more rapidly than NaCl. Bromium and iodine salts of K and Na also remove opacity although the glass is not as transparent as when KCl is used. Boric acid removes opacity in glasses containing B_2O_3. Pb_3O_4 and ZnO also remove opacity. M.V.K.

Devitrification. F. W. PRESTON. *Glass Ind.*, **12** [1], 1–3 (1931).—P. reviews the work of G. W. Morey (see *Ceram. Abs.*, **9** [11], 922–23 (1930)) and Adolf Dietzel (see *Ceram. Abs.*, **9** [7], 516; [8], 625; [9], 726; [10], 831 (1930)) on soda-lime-silica glasses, pointing out some differences in their findings. Of the crystals formed during devitrification, Dietzel discovered only two crystal compositions, one of which he calls cristobalite (SiO_2) and the other wollastonite or pseudo-wollastonite ($CaO{\cdot}SiO_2$). From Morey's work it would appear that the cristobalite should in all cases have been tridymite, another form of SiO_2, while more often than not, wollastonite should have been the 1:3:6 compound ($Na_2O{\cdot}3CaO{\cdot}6SiO_2$), which is not merely a different crystal form but a different chemical compound. Morey has provided an equilibrium diagram of the field of soda-lime-silica mixtures whose proportions of the different oxides are in or near the region of those employed by practical glass men. In his discussion of the work and diagrams, P. makes a few observations that may enable the glassman to use with advantage the work of D. and M. and may help him apply it to the study of his own glasses. Illustrated. E.J.V.

Surface contractions and surface devitrification of glass. K. TABATA. *Jour. Soc. Chem. Ind.* [Japan], **33** [3], 95–96*B* (1930).—Surface contraction is a condition of the utmost importance in the study of the surface devitrification of glass. When complete surface contraction accompanies surface devitrification, the crystallization of silica is markedly seen. M.V.K.

Density and composition of soda-silica glasses. ANON. *Jour. Frank. Inst.*, **211**, 251 (1930); *Sprechsaal*, **63** [44], 838 (1930).—The glasses investigated contain between 55 and 80% silica and the remainder, Na_2O. The densities found in the glasses relieved from tension can be expressed in terms of their dependence on the composition by means of the following equations: $D = 0.07977\ (86.5 - A)^{0.42107} + 2.203$, where $A = SiO_2$ and $D = 0.00301\ B - \frac{2.988}{B - 1} + 2.4756$, where $B = Na_2O$. M.V.K.

Index of refraction vs. composition of soda-lime glasses. ANON. *Glass Ind.*, **12** [1], 3 (1931); for abstract see *Ceram. Abs.*, **9** [6], 418 (1930). E.J.V.

Use of rocks in glassmaking. I. I. KITAIGORODSKY AND S. W. RODIN. *Glass*, **7** [12], 488–89 (1930).—The research work on the above problem was carried out by the State Institute for Glass Research in Moscow. Trachyte rocks were selected for the first study. No alkalis were to be added. A systematic study of the behavior of rocks in glassmelting, of the quality and quantity of other constituents necessary to hasten

the process of glass formation, and of the temperature conditions favorable to the process has been made. Correct thermal conditions are most important. All the constituents of rocks favor devitrification except alumina and the percentage of alumina is high and offers additional difficulties. The amount of trachyte in the batch was to be at least 50% and preferably 75 to 80%. Potash, red lead, and boric acid were not used. Tables of the chemical compositions of a great number of rocks are given. The suitability of different kinds of rocks for use in glassmaking is based on the similarity of their composition to the composition of the glass. High ferric oxide colors the glass greatly. Too high alumina causes difficulty in melting, a hard quick-setting glass which is very viscous, high mechanical strength, resistance to sudden temperature changes, and resistance to acid and alkali. Calcium oxide may be added if the alkali content is low and alumina too high. Calcium oxide counteracts the effect of alumina causing it to react like silica. H.W.A.

Fusing glass containing blast-furnace slag. I. I. KITAIGORODSKY AND I. P. KAREV. *Ceramics & Glass*, **6** [10], 465–66 (1930).—Tests showed that granulated blast-furnace slag (composition is given) can be used as an admixture in glass. Glass containing 30% of its weight in blast-furnace slag was composed of 70% silicic acid, 3.2% Al_2O_3, 16% CaO, and 10% Na_2O. The glass obtained was of good quality. The batch was made up of sand 1000 kg., sulphate 275 kg., soda 160 kg., slaked lime 180 kg., and wood coal 10 kg. The glass contained 15% sodium oxide. See also *Ceram. Abs.*, **9** [12], 1031 (1930). M.V.K.

Developments in the use of borax. ANON. *Glass Ind.*, **12** [1], 18 (1931).—For many years various beneficial effects obtainable with borax and B_2O_3 have been known. Certain physical properties imparted have been carefully determined and confirmed. The separate and joint effects of borax and alumina have been considered. In general, the reaction of glassmakers to the use of borax has been favorable. E.J.V.

Density vs. composition of soda-silica glasses. ANON. *Ceram. Ind.*, **15** [2], 217–18 (1930); for abstract see *Ceram. Abs.*, **9** [10], 831 (1930). W.W.M.

Behavior of glasses in their softening interval. G. TAMMANN. *Z. Elektrochem.*, **36,** 665–75 (1930); for abstract see *Ceram. Abs.*, **9** [8], 623 (1930). (*C.A.*)

Platinizing glass and other substances. G. F. TAYLOR. *Jour. Opt. Soc. Amer.*, **18,** 138–42 (1929).—Improved methods are described of preparing and applying a platinizing solution of platinic chloride, oil of rosemary, and oil of lavender, so as to obtain either a surface which can be soldered or a fine, flawless mirror. Various properties of the films and applications of the method are described, and other materials which can be similarly treated are mentioned. (*C.A.*)

Chemical and mineralogical composition of stalactites from two glass factories. D. S. BELIANKIN. *Bull. acad. sci. union rep. soviet. social* [*Classe sci. phys.-math.*], 257–65 (1930) (summary in French).—Stalactites from the Vélikodvorsky and the Droujnayat-Gorka plants were studied. Chemical analyses of the furnace lining (Dinas brick), the glass, and the stalactites, respectively, of the former were SiO_2 93.82, 71.87, 90.35; (Al, Fe)$_2O_3$ 2.43, 2.03, 2.33; MnO —, 0.13, 1.19; MgO 0.09, —, 0.15; CaO 2.38, 14.69, 3.19; (Na, K)$_2$O 0.12, 11.58, 2.79%. For the latter, the values were SiO_2 93.73, 73.18, 88.01; (Al, Fe)$_2O_3$ 4.75, 1.84, 2.76; CaO 1.48, 8.20, 6.77; (Na, K)$_2$O —, 16.78, 2.19. The stalactites from the former were composed of tridymite, cristobalite, and monoclinic pyroxene; those from the latter were composed of tridymite and pseudo-wollastonite. Four photomicrographs are reproduced. See also *Ceram. Abs.*, **9** [1], 20 (1930). (*C.A.*)

Manufacture of rolled plate. IV. ERNST LUTZ. *Glass Ind.*, **12** [1], 6–11 (1931).—A detailed description is given of the construction and operation of a traveling crane type of machine used for handling glass pots full of molten glass. The lay-out of a

rolled plate glass factory is discussed from the standpoint of the greatest efficiency obtainable. A removable casting table with roller and roller carriage for a rough glass factory with single annealing kilns is described in detail as to construction and operation. Illustrated. For Part III see *Ceram. Abs.*, **10** [2], 109 (1931). E.J.V.

Optical glasses. PARSON OPTICAL GLASS CO. *Glass Ind.*, **12** [1], 5 (1931).—Some seventy glasses are described and the optical properties listed, including the refractive index for the yellow helium line and the dispersion and particle dispersions. Until comparatively recently it was customary to use only the sodium yellow and the hydrogen red and blue, and perhaps the hydrogen violet line, in specifying the optical properties. In the new catalogue the helium yellow replaces the sodium for most purposes and a more complete range of dispersive values is obtained by adding the helium deep red (*b* line) and the mercury green, blue, and violet to the three hydrogen lines. The helium yellow (5875) is quite close to the old sodium doublet 5893 and is more convenient with modern technique. The addition of the mercury lines and the helium red at 7065 will be of advantage to the designer who needs an exceptional degree of achromatism. E.J.V.

How to reduce breakage in glassware. RENÉ LEONHARDT. *Glass Ind.*, **12** [1], 15 (1931).—The strain-viewer described makes it possible to detect the strains resulting from the cooling process. The rays from a lamp are polarized by means of a curved mirror of smoked glass mounted horizontally on a base plate, and are reflected through an aperture and the viewing tube. These glassware strain-viewers are made by the Askania Werke A.-G., Bambergwerk, Berlin-Friedenau, Germany. Illustrated. E.J.V.

New British bottle-making machine. ANON. *Glass Ind.*, **12** [1], 20 (1931).—A new glassmaking machine for turning out airtight containers at the rate of 150 bottles per minute has just been perfected at the Albion Works, Leeds. E.J.V.

Examination of antique glass. E. BERL AND F. BENDER. *Chem.-Ztg.*, **54**, 913–14 (1930).—A glass goblet, which had become opaque through age and had developed thin surface flakes gave on analysis 72.8% SiO_2, 19.3% (K_2O + Na_2O), and 5% CaO; the flakes contained 73.4% SiO_2, 18.6% (K_2O + Na_2O), and 5.48% CaO. This close approximation in the relative compositions indicates that atmospheric conditions, which appreciably affect glass of high alkali content, have not been responsible for the deterioration. Confirmation for this lies in the fact that the ground portions, usually specially susceptible to atmospheric influences, show no attack. It is concluded that the effects were caused by strains in the external surface developed by irregular cooling in manufacture, the absence of internal strain being due to the use of an interior mold. Old glass is best protected by a coating of cellulose lacquer, but the effects of strains can be prevented only by re-annealing. (*B.C.A.*)

Ultra-violet transmission of "Vita" glass. ANON. *Glass*, **7** [9], 369 (1930).—An abstract of an Interim Report of the Department of Scientific Industrial Research on the ultra-violet transmission of "Vita" glass is given. H.W.A.

Manufacture of quartz glass windows. ANON. *Engineering*, **128**, 815 (1929); for abstract see *Ceram. Abs.*, **8** [12], 876 (1929). H.H.S.

Metal-window industry. R. C. PENBERTHY. *Jour. N. Z. Inst. Arch.*, **9**, 79–80 (1930). H.H.S.

Commercial standards for mirrors. MINITA WESTCOTT. *Commercial Stand. Monthly*, **7** [7], 213 (1931).—Five grades were created corresponding to the qualities furnished by the plate-glass manufacturers. Qualities are defined for both the manufacturer and consumer. E.J.V.

Electrically conductive antimony mirrors on glass. STANDISH MILLER. *Jour. Opt. Soc. Amer.*, **19**, 101–102 (1929). (*C.A.*)

Glass-iron-concrete and its use. H. CRAEMER. *Zement*, **19** [50], 1185–88 (1930).—C. discusses the properties and advantages of using glass blocks combined with concrete in buildings. Different tests to determine the solidity, resistance, and fire-proofness of glass-concrete are described. M.V.K.

Glass in the kitchen. FLORENCE BROBECK. *Forecast*, pp. 210–11 (Oct., 1930).—B. discusses the amount and variety of glassware now used in keeping house. (*D.I.*)

Record production in glass industry. ANON. *Can. Chem. Met.*, **15** [1], 35 (1931).—The production of the 60 Canadian glass factories last year was valued at $15,507,442, a record value 11% more than the last high, in 1927. Of this total, 54 plants manufactured plate, cut, or ornamental glass, and 6 pressed and blown glass. Imports of glass and glassware were appraised at $10,569,457, while exports were valued at $100,507. E.J.V.

Polished plate-glass production in 1930. P. A. HUGHES. *Glass Ind.*, **12** [2], 43 (1931).—With the December production of polished plate glass in the U.S. of 4,941,405 sq. ft., the total production for 1930 amounted to 105,824,074 sq. ft., a decrease of 44,674,213 sq. ft. from the total production for 1929. E.J.V.

John Kunkel (von Lowenstiern) tercentenary. EDITORIAL. *Chem. & Ind.*, **49**, 268 (1930).—K.'s most valuable work was his treatise on glassmaking; he also manufactured ruby glass. Born in Schleswig in 1630, he died at Stockholm in 1702. The Swedish king, Charles XI, ennobled him as Baron von Lowenstiern. H.H.S.

PATENTS

Glassfeeding mechanism. THEODORE C. STEIMER. U. S. 1,788,413, Jan. 13, 1931. In glassfeeding apparatus, a glass container having a submerged outlet, a vertically-reciprocable operating mechanism adjacent to the container, a carrier movably supported on the operating mechanism and extending to a position over the outlet, an implement depending from the carrier into the glass in the container for movement with the carrier toward and from the outlet, and adjusting and securing means operable to positively adjust the carrier on the operating mechanism to vary the position and effect of the working stroke of the implement on the glass at the outlet and to firmly hold the carrier in adjusted position on the operating mechanism.

Sheet-glass apparatus. NESTOR MAMBOURG. U. S. 1,788,923, Jan. 13, 1931. In sheet-glass apparatus, a receptacle containing a mass of molten glass, means for drawing a sheet therefrom, a metallic shield arranged on each side of the sheet, an end of both shields terminating beneath the surface of the molten glass, and means for internally heating both of the shields.

Glassworking machine. GEORGE A. MILLAR. U. S. 1,788,926, Jan. 13, 1931. In a machine for shaping glass tubing, in combination, means for supporting and closing a glass tube at one end thereof, means for supporting and closing the tube at its other end and for making connection adapted for applying air pressure to the interior of the tube, means tending to move the first means toward the second means, and a positioning member in operative relation to the tube adapted to receive a projection therefrom.

Glassworking machinery. GEORGE A. MILLAR. U. S. 1,788,927, Jan. 13, 1931. In a machine for making tubular glass devices, in combination, means for supporting and closing a glass tube, for making connection adapted for applying air pressure to the interior of the tube, and for rotating a tube held thereby about its axis, means for heating the tube, means for holding a lead wire and a second tube at an angle to the first-named tube and for moving each, in turn, to and from the first-named tube, and means for applying pressure to the interior of the tube and for controlling the pressure.

Glassworking machinery. ROY D. MAILEY AND WILFORD J. WINNINGHOFF. U. S. 1,788,954, Jan. 13, 1931. (1) In a glassworking machine a clamp adapted for holding a glass piece during rotation thereof, comprising a shaft, a fork member extending from the shaft, a lever pivoted to each of the prongs of the fork, clamping jaws carried by the prongs and having connection with the levers whereby they may be opened and closed by movement of the levers on their pivots, means tending to hold the clamps open, and means for closing the clamps comprising a cone slidable axially on the shaft and projections on the levers for engaging the cone. (2) In a machine for working hollow glassware, a support, a driving shaft mounted on the support, a second shaft adapted to be driven by the first shaft, a glass-holding clamp on the second shaft, heating means in operable relation to glassware carried by the clamp, and a clutch member mounted on the driving shaft comprising a loosely-mounted flange member having a gear and a notched boss thereon, a second flange fixed to the driving shaft facing the boss and having an annular shoulder extending about the boss, and a member carried by the second flange, slidable into and out of engagement with the notches of the boss.

Making incandescent lamps, etc. ROSCOE G. PHELPS. U. S. 1,788,957, Jan. 13, 1931. The method of accurately positioning a filament of an electric incandescent lamp or similar device with reference to locating means carried by a base which includes locating in a sealing apparatus a mount comprising a glass stem and a filament with the latter definitely disposed relatively to the axis of the stem and with its plane having a definite relation to that of a flat portion of the stem and utilizing the flat portion to locate the stem definitely with relation to the head of the sealing machine.

Glassworking machinery. ROY D. MAILEY AND WILFORD J. WINNINGHOFF. U. S. 1,789,011, Jan. 13, 1931. In a machine for joining hollow glass, means for holding two pieces of hollow glass in alignment, means for relatively moving pieces held by the holding means relatively toward and from each other, means for moving pieces in the holding means relatively transversely of each other comprising a support member for one of the glass-holding means and a ball and socket joint in the support member, means for heating glassware held in the holding means, and means for applying and for varying air pressure in the glass pieces.

Glassworking machine. GEORGE A. MILLAR. U. S. 1,789,014, Jan. 13, 1931. In a machine for fusing glass sleeves on metal stems, in combination, means for supporting a stem substantially vertically, means for supporting a glass sleeve about the stem in a predetermined position with respect to the stem, the first means being movable axially with respect to a stem held thereby, means for heating the sleeve to fuse it about the stem, and means for moving the stem-holding means to carry a sleeve fused to its stem away from the sleeve-holding means and to bring the part of the sleeve which was adjacent to the sleeve-holding means from that position and into a position within the influence of the heating means.

Fluid-cooled roll. ALBERT E. EVANS. U. S. 1,789,356, Jan. 20, 1931. In combination in a roll, a cylindrical casing, a liquid supply pipe extending inward from each end of the casing and discharging at its inner end, a second pipe also extending inward from each end of the casing surrounding the supply pipe and concentric therewith, receiving the discharge from the supply pipe and provided with a series of perforations at its inner end, means for supplying a cooling fluid under pressure to the outer end of each supply pipe, means for withdrawing the fluid from the outer ends of the casing means for supporting each of the second pipes intermediate its ends from the casing, and means for supporting each of the supply pipes from one of the second pipes.

Forming hollow glass articles. BYRNE MCGOVERN. U. S. 1,789,471, Jan. 20, 1931. A mold bottom plate formed with passageways extending upwardly there-

through for the passage of cooling air and opening laterally to the exterior of the bottom plate at a position or positions below the upper surface of the plate, a hollow plate holder on which the plate is mounted, the plate holder being provided with passageways for the passage of cooling air through the upper wall of the plate holder, some of the last-mentioned passageways being in register with the first-mentioned passageways and others arranged to open exteriorly of the bottom plate, and adjustable cover plates for the passageways which open exteriorly of the bottom plate for adjustably restricting and regulating the supply of air therethrough.

Feeding molten glass. LEONARD D. SOUBIER. U. S. 1,789,480, Jan. 20, 1931. In combination, a container for molten glass having a bottom outlet orifice, a cup arranged to periodically enclose the lower side of the orifice, the cup comprising a pair of telescoped sections, means to normally hold the sections in their extended positions, means to cause a relative movement of the sections while the cup encloses the outlet orifice to create super-atmospheric pressure internally of the cup causing upward movement of glass in the orifice, and means operating at predetermined time intervals to apply vacuum internally of the cup to accelerate outward flow of glass through the orifice.

Glass manufacture. MAX METH. U. S. 1,789,658, Jan. 20, 1931. A glass having a low coefficient of expansion resulting from the fusion of a batch comprising soda, lime, silica, and a quantity of a beryllium compound.

Manufacture of wire-glass plates with wires running in one direction. ADOLF ENGELS. U. S. 1,790,043, Jan. 27, 1931. A device wherein the resilient pressure rollers are arranged so that they may be brought out of engagement with the clutch roller for the purpose of threading the wires.

Glassworking machine. WILLIAM J. WOODS AND DAVID E. GRAY. U. S. 1,790,397, Jan. 27, 1931. (1) The hereinbefore described process of making blown-glass articles which comprises forming a ribbon of glass from a parent body and progressively and sequentially blowing articles from the glass of the ribbon as it moves away from its point of origin. (2) In a glassforming machine the combination of a moving ribbon conveyer having orifices therein, of a stripper adjacent to the conveyer and rotating in a plane inclined to the face of the conveyer.

Leer for annealing glassware. VERGIL MULHOLLAND. U. S. 1,790,434, Jan. 27 1931. A continuous leer for annealing glassware comprising a tunnel, a pair of temperature-controlling flues surrounding the tunnel in a double helix, means adjacent to the hotter ends of the flues for supplying independently regulable amounts of heating media thereto, a plurality of independent dampered air-inlet openings disposed at intervals along each flue, a suction device, a conduit leading therefrom along the tunnel, and a plurality of independent dampered passages communicating between each of the flues and the conduit, whereby to control the effective length of the heating flues and the temperature gradient in the tunnel, the suction device maintaining both flues at subatmospheric pressure.

Glass-annealing leer. KARL E. PEILER. U. S. 1,790,630, Jan. 27, 1931. A glass-annealing leer comprising an elongate tunnel having an entrance portion formed at right angles to the direction of movement of glass entering the tunnel, a substantially helical flue coiled about at least the ware-entering portion of the tunnel, means to pass hot gases through the flue to control the temperature within the tunnel, the flue having at least a portion of its first turn spaced from the entrance end of the tunnel due to the substantially helical construction thereof to form a substantially triangular space between such portion and the right angular entrance end of the tunnel, and means for supplying heat to the space.

Glassware manufacture. PIERRE ARBEIT. U. S. 1,790,633, Jan. 27, 1931. A

glassworking machine comprising a suction-fed parison mold, means for advancing and retracting the mold toward and away from a charging position above a body of molten glass, a scraper moving ahead of the mold in its movement toward the charging position, and means for actuating the scraper and arranged to lower the scraper to engage the glass during the advancing movement of the mold, and for raising the scraper and holding it above the glass during the retracting movement of the mold.

Glass-spreading roll. PAUL JOSEPH MAXIMILIEN ESCOLE. U. S. 1,790,700, Feb. 3, 1931. A glass-spreading roll comprising a hollow cylindrical body, means for dividing the interior of the body into two compartments of equal capacity located symmetrically of its central transverse plane, means for supplying cooling water to the interior of the body in the vicinity of the central plane, end closures at opposite ends of the roll, the closures fitting into counterbored portions of greater internal diameter than the remainder of the interior of the body, annular chambers in the closures, water channels connecting the annular chambers with the counterbored portions, the water channels and the annular chambers being of external diameters greater than the internal diameter of the counterbored portions, and means for the escape of water from the annular chambers.

Drawing sheet glass. ARTHUR E. SPINASSE. U. S. 1,790,774, Feb. 3, 1931. An anchoring device for use in drawing sheet glass, consisting of a hollow body having a conical point and a pipe extending into the hollow body and adapted to convey to the point a temperature-regulating medium.

Glass-tank construction. KARL G. KUTCHKA. U. S. 1,790,820, Feb. 3, 1931. In combination with a container for molten glass, a permanent cover or roof for the container in opposition to the surface of the glass and closely adjacent thereto and including a refractory member formed on its lower face so as to promote surface combustion, means for supplying gas and air through the body of the member to the lower face thereof, and means for supporting the member from above for vertical movement in order to maintain the flame of combustion close to the surface of the glass, but in spaced relation with respect thereto.

Glassfeeding mechanism. EVERETT S. GREER. U. S. 1,790,984, Feb. 3, 1931. A glass feeder including a flow spout having a flow orifice, a bushing arranged in the orifice and extending above the floor of the flow spout, and a reciprocable feeder member, the feeder member being hollow and of such internal diameter as to embrace the bushing, the interior of the feeder member being always at atmospheric pressure.

Treating glass articles. ROWLAND D. SMITH. U. S. 1,791,066, Feb. 3, 1931. The method of treating frosted glass articles which includes washing them in a water solution of a simple aluminium salt of an aliphatic organic acid.

Making wire glass. GEORGE AURIEN. U. S. 1,791,260, Feb. 3, 1931. In a machine for forming wire glass, in combination, a pair of rolls forming a pass therebetween for forming a first half-sheet, means comprising one of the rolls for conducting the half-sheet from the pass, whereby the half-sheet is slightly stiffened, means for placing wire mesh on the convex surface of the stiffened half-sheet, and means comprising rolls forming a second roll pass for forming the finished sheet by adding another half-sheet outside of the wire, and means comprising a concave apron for subsequently guiding the sheet to the leer, the guiding means acting to maintain the wire on the convex surface of the first half-sheet until the sheet is sufficiently stiffened to prevent displacement of the wire from its central position in the sheet.

Glassworking. KARL E. PEILER. U. S. 1,791,323, Feb. 3, 1931. Apparatus for fabricating glass parisons comprising a parison mold for gathering a charge of glass from the surface of a gathering pool by suction, an auxiliary mold for engaging the bottom of the parison mold after the charge is gathered, and for encircling the string

of glass connecting the charge with the glass in the gathering pool, the mold having an opening formed therein which forms a continuation of the cavity in the parison mold when the molds are in engagement, a shear blade for severing the string of glass at a plane substantially coincident with the bottom of the auxiliary mold, and for covering the bottom of the opening in the auxiliary mold, a neck pin for forming an initial blowing cavity in the charge of glass, and a blow head for admitting preliminary blowing air into the cavity to enlarge the cavity and to shape the bottom of the charge in the auxiliary mold.

Charging glass furnaces. J. E. POLLAK. Brit. 337,950, Dec. 31, 1930. Apparatus for feeding the batch to a glassmelting furnace comprises a reciprocating chute or trough within which is a fixed shovel adapted, as the trough moves rearwardly, to effect delivery into the furnace of the charge material fed to the trough during its forward movement.

Glass manufacture. L. MELLERSH-JACKSON. Brit. 337,988, Dec. 31, 1930. Relates to a feeder of the kind in which the flow of molten glass through an aperture in the floor of a forehearth is regulated by variations in the pressure of the air within a vertical tube that dips into the glass above the aperture.

Glass manufacture. L. MELLERSH-JACKSON. Brit. 337,989, Dec. 31, 1930. The invention consists in providing means for automatically keeping constant the temperature of the glass above the outlet in order to maintain uniformity of the successive charges of glass delivered by the feeder. As the temperature of the glass below the thermocouple rises or falls, the motor is actuated either to cut off or supply fuel to the burners and thus to supply heat when necessary to the glass above the outlet. The device can be used for controlling the flow of glass through the outlet of a tube submerged in the glass and having its interior alternately connected with a vacuum tank or a compressor.

Glass manufacture. A. E. WHITE. Brit. 338,045, Dec. 31, 1930. A method of removing the thickened edges of a glass sheet which is produced as a continuous ribbon by a drawing process consists in heating the glass along lines parallel with and close to the edges for a distance corresponding to the length of a section to be severed from the ribbon, removing the section, and then applying a cooling device to the heated lines to cause the glass to crack along the lines. The invention is used in conjunction with an apparatus for cutting a continuous ribbon of glass into sections.

Glass manufacture. BRITISH HARTFORD-FAIRMONT SYNDICATE, LTD. Brit. 338,089, Jan. 7, 1931. A method of cooling and lubricating the shear blades of a glass feeder consists in discharging moistened air onto the retracted blades from points situated above the level of the blades and nearer to the feeder outlet, so that the cooling blast is not deflected or projected onto the glass as it flows through the outlet.

Cutting glass. BRITISH THOMSON-HOUSTON CO., LTD. Brit. 338,299, Jan. 7, 1931. A machine for cutting up lengths of glass tubing or cane comprises a series of aligned chucks which receive the lengths of tube from a delivery device and convey them to scoring and breaking devices, the chucks being opened automatically to discharge the short lengths as they are formed.

Glass manufacture; color filters. DEUTSCHE GASGLÜHLICHT-AUER-GES. Brit. 338,334, Jan. 7, 1931. A light filter for accentuating color contrasts is made of glass that is colored with neodymium oxide. Other coloring materials may be incorporated with the glass to secure the desired optical effect. *E.g.*, cerium oxide may be added to absorb ultra-violet rays, or chromium oxide or praseodymium oxide may be used to make objects colored green appear more pronounced. The glass may be used for spectacle lenses, for obtaining special illuminating effects, or for separating narrow bands of the spectrum.

Glass manufacture. Soc. anon. des verreries à Bouteilles du Nord. Brit. 338,395, Jan. 7, 1931. A machine for forming a "push" or recess in the bottom of a glass bottle comprises a rotating turret provided with carriers for bottles, and a recessing plunger operated by compressed air, the machine being rotated in unison with the bottle-making machine.

Fused silica. Quartz et Silice. Brit. 338,456, Jan. 14, 1931. Relates to the method of forming articles of silica in which a cylindrical blank, while still incandescent after removal from the carbon rod on which it is formed, is blown to shape in a mold. According to the invention, the inner surface of the mold is drilled, grooved, threaded, or perforated, the cavities so formed being intended to receive the unfused raw material that adheres to the incandescent blank. In a modified construction, the molding surface is a grid made up of flat bars bolted together with spacing washers between them. The grid is supported by a mold body.

Fused silica. Quartz et Silice. Brit. 338,457, Jan. 14, 1931. Relates to a method of molding articles from fused silica or other refractory vitreous material, and fining the material at the same time that it is brought to the required shape. According to the invention, a silica blank is heated to a very high temperature as described in Brit. 283,174 (see *Ceram. Abs.*, **7** [5], 305 (1928)), the incandescent material is placed in a cylinder between pistons and it is then pressed so that it is driven outward at a high speed through orifices into cavities formed in a mold body. The soundest portion of the silica blank is forced into the cavities and the part that remains between the pistons retains the bubbles or flows which existed in the blank.

Glass manufacture. Y. Brancart. Brit. 338,477, Jan. 14, 1931. A method of insulating a glass sheet from a receiving surface consists in producing a gaseous cushion between the sheet and the surface by means of gases evolved from a combustible material which is burned or charred by the heat of the glowing glass. The surface may be coated with the combustible material before receiving the glass, or it may be perforated and the combustible material placed under it so that the gases escape through the perforations. Alternatively, a rod coated with the material, or a hollow perforated rod filled with the material, may be passed between the glass and the receiving surface. The material may be a liquid, such as petrol, or pulverized charcoal or sawdust may be used in the dry state or mixed with a liquid.

Cutting glass. A. E. White. Brit. 338,778, Jan. 14, 1931. Relates to the apparatus described in Brit. 338,045 for removing the edges of a continuously-formed ribbon of glass. The invention consists in providing means for removing the edge-severing strips in advance of the application of heat to the transverse strips, and for supporting them so that they adjust themselves to the position of the glass ribbon. The invention, as described in the prior specification, is used in conjunction with a device for cutting off sections from the continuous ribbon of glass by electrically heating the glass along a transverse line and then chilling it to cause it to crack.

Fused silica. Quartz et Silice. Brit. 339,197, Jan. 21, 1931. Relates to a mold, described in the parent specification, for blowing articles of fused silica, and to the particular construction in which the molding surface is constituted by a grid made of bars supported by the solid body of the mold. According to the present invention, the solid body of the mold is dispensed with, the bars that constitute the grid being made sufficiently strong to resist distortion by pressure and warping by heat. The bars may be grooved on their molding faces, and they may be assembled in contact with one another or separated by spacers. A mold for making tubular articles can be made by fixing the bars in end pieces which can be changed as desired.

Pressing glass. Chance Bros. & Co., Ltd., and R. Brown. Brit. 339,484, Jan. 28, 1931. A process for the production of molded glassware consists in pressing

each article in two or more stages, the shaping of the major part of an article being effected in a single-piece or equivalent mold, the subordinate part or parts being shaped in a separate segmental mold or molds.

Glass manufacture. CHANCE BROS. & CO., LTD., AND A. L. FORSTER. Brit. 339,535, Jan. 28, 1931. A device for forming plate or sheet glass comprises a system of three rollers in immediate conjunction with the outlet or discharge of a furnace, and a support or guide situated on the delivery side of the rollers, the two upper rollers being so situated that their axes lie on opposite sides of the vertical plane containing the axis of the lower roller. When making wire glass, the roller is provided with longitudinal, helical, or other ribs or projections whereby a sheet of wire mesh can be embedded in the glass prior to its entrance between the rollers.

Glass manufacture. Y. BRANCART. Brit. 339,546, Jan. 28, 1931. A roller for forming plate glass is adjustable vertically above the casting table in order that the thickness of the plates formed by the roller may be varied.

Glass manufacture. C. LOCREILLE. Brit. 339,583, Jan. 28, 1931. A process for making marbled or multicolored glass consists in preparing masses of glass of different colors but having substantially the same composition, melting the glasses in separate pots or furnaces, and adding to one of the glasses separate quantities of the others. The temperature of the molten glass that forms the ground color must be as high as possible, while the temperature of the glasses to be added may be lower at the time of operation.

Heavy Clay Products

Systematic examination of the behavior of soluble salts in clays. III. A. SIMON AND W. VETTER. *Ber. deut. keram. Ges.*, **11** [6], 313 (1930).—The first article describes the behavior of the chlorides and sulphates of sodium, potassium, magnesium, and calcium in three different types of clay: (1) a normal brick clay, (2) an early sintering clay rich in iron and free of carbonates, and (3) Zettlitz kaolin. In the second report, results are given of examinations of mixtures of the above-mentioned salts during the firing, in each of these three types of clay. After the firing to 900 to 1000°, all the chlorides and sulphates evaporate, decompose, or change to a calcium sulphate which is the same at these temperatures and present in such quantities as to cause scum. The supposition that calcium sulphate will not cause scum was investigated. A certain amount of gypsum was added to clay and at different temperatures, between 300 to 1000°, fired for 7 hr. By 48 hr. water extraction practically all of the added gypsum could be extracted. Plaster of Paris will be soluble enough to cause scum. Different salts such as KCl, Na_2SO_4, $MgSO_4$, and $CaSO_4$ were tested and it was found that the chlorides are the easiest to wash out, and the sulphates in dry as well as in fired state are more difficult to get in solution. By firing, the solubility of the salts is lowered. The influence of the firing time was also considered. Usually the kilns were fired only 7 hr.; to proximate commercial firing, however, they were fired for 24 hr. Magnesium chloride will not be influenced in its behavior after 4 hr. of firing. Magnesium sulphate will give up half of its SO_3 after 4 hr. and later will lose less. After 4 hr. firing the larger part of the sulphate can be extracted. Longer firing, however, at higher temperatures will cause more decomposition than with the chlorides. After 4 hr. firing to 750° no chlorine could be detected and the sodium sulphate had given up most of its SO_3. The decomposition of salt will be chiefly finished after 4 hr. firing and a longer heating at the same time will only cause a slight increase in this decomposition. See also *Ceram. Abs.*, 9 [6], 427 (1930). I.R.

Florescence of clay products. ANON. *Brit. Clayworker*, **39** [465], 376–77 (1931).—Methods have been developed for the estimation of small quantities of sodium, potassium, calcium, and magnesium in aqueous extracts from clays and brick. The reaction

of these bases with sulphur dioxide in the kiln gases is the principal cause of the presence of soluble salts in fired clayware. It appears certain that bases are present in clays in at least three forms: (*a*) soluble salts, principally sulphates; (*b*) exchangeable bases; (*c*) combined with silica and alumina as in feldspars and nonzeolitic compounds. It was found that the proportion of soluble salts is markedly affected by the temperature of firing, the maximum occurring at about 700°C with a gradually decreasing amount as temperature of firing is increased. Because potassium sulphate in a clay is decomposed on heating to 700°C and calcium sulphate is comparatively stable up to 1000°C, it can readily be seen that a clay brick containing a large percentage of the calcium sulphate is much more apt to retain salts causing florescence. The failure of lime plaster applied to brickwork appearing as having been pushed away bodily from the brickwork has been found to be caused by large masses of magnesium sulphate crystals. This stresses the importance of the magnesium sulphate content of brick as a cause of injury to applied plaster. R.A.H.

Water in brick. ANON. *Brit. Clayworker*, **39** [464], 337 (1930).—One reason why most handmade brick are so durable is that the material of which they are made has been thoroughly moistened, whereas in many machine-made brick the water is irregularly distributed and the plasticity of the brick has not been fully developed. Frequently, an insufficiently or irregularly moistened material produces cracked or distorted brick. Even in the semidry press process in which little or no water is added, the moisture present must be suitable in amount and uniformly distributed or the brick will not possess the necessary strength and durability, either before or after firing. The methods of adding water to clay are seldom studied, though they offer much scope for research. They are not only important in themselves, but also in their results, for the manner in which water is added to clay has a pronounced effect on the clay whereby the water leaves the clay in drying. R.A.H.

Strength of masonry of hollow units. ANON. Bur. Stand., *Tech. News Bull.*, No. 165, pp. 1–2 (1931).—With the object of evaluating some of the factors affecting the strength of masonry, a study has been made of the data on the compressive strength of large masonry specimens of hollow clay units reported in the Univ. of Ill., *Bull.*, No. 27 and the Bur. Stand., *Tech. Papers*, Nos. 238 and 311. A summary of the conclusions drawn is given. R.A.H.

Fire-resistance tests. S. H. INGBERG. *Commercial Stand. Monthly*, **7** [7], 215–16 (1931).—The standard fire test consists in subjecting the material, construction, or device to a furnace fire, the intensity of which is so regulated that given average temperatures are obtained in the furnace chamber at stated times after the fire is started. By means of this control, approximately the same fire exposure can be obtained at different times and in different laboratories. The other requirements will vary with the type of construction or device being tested. Some of the tests which have been made are described and referred to. See also *Ceram. Abs.*, **8** [4], 269–70 (1929). E.J.V.

Designs for reënforced brickwork. HUGO FILIPPI. *Brick Clay Rec.*, **78** [1], 27–34 (1931); *Clay-Worker*, **95** [1], 33–34 (1931).—Reënforced brick masonry makes good load-bearing material because it resists bending stresses. This series of tests was planned to develop the basic principles of design and to indicate the field for further research. Twenty-four beams and slabs were constructed of four different types using two kinds of cement lime mortar. The procedure followed is described in detail. A summary of test results is given. These tests point clearly to the possibilities of reënforced brickwork and constitute a definite step toward its favorable consideration in the design of building and engineering structures. Illustrated. E.J.V.

Dam facing with reënforced brickwork. ROSS F. TUCKER. *Clay-Worker*, **95**

[1], 32–33 (1931).—A description of the brick-faced concrete dam built near Ithaca in 1905 by Vinton & Tucker, probably one of the earliest applications of reënforced brickwork, is given. The construction method employed is discussed in some detail with the aid of illustrations. E.J.V.

Use of common brick. A. F. GREAVES-WALKER. *Ceram. Age*, **16** [4], 226–27 (1930).—The larger buildings are now using large units instead of brick not only for backing but even for facing. The house appears to be the one field where the brick manufacturer has an opportunity for the small standard unit. Brick still cost more than lumber and these costs must be reduced before brick manufacturers can meet its competition. It is not necessary to differentiate between face brick and common brick or to have separate associations. A.E.R.W.

Sewer pipe. A. F. GREAVES-WALKER. *Ceram. Age*, **16** [1], 12–13 (1930).—The reasons why concrete sewer pipe is more in demand than clay pipe are discussed. Manufacturing costs must be reduced and this can be done by elimination of the salt glaze because (1) a single shale or fire clay could then be used, (2) an ordinary tunnel kiln would fire the ware on an exceptional schedule, and (3) there would be fewer rejections as most of these come through warpage produced during the salting process. Another money-saving scheme would be the use of the tunnel drier. To sell unglazed pipe it would be necessary to change A.S.T.M. specifications. A.E.R.W.

Lintel construction. ANON. *Clay-Worker*, **95** [1], 34–35 (1931).—Detailed descriptions of the construction of reënforced brick lintels used in the reconstruction of plant buildings at the Alwine Brothers Brick Co. at New Oxford, Pa., are given. Illustrated. E.J.V.

Physical tests of Ohio shales and surface clays. C. R. AUSTIN. *Brick Clay Rec.*, **78** [2], 104 (1931).—A progress report on this investigation is presented, giving details as to various tests made and methods used in performing them. E.J.V.

Clay products in air ports. ANON. *Clay-Worker*, **95** [1], 21–23 (1931).—Some examples of the use of clay products in the construction of hangars and in the preparation of the landing field in air ports are cited and discussed. Illustrated. See also *Ceram. Abs.*, **10** [3], 191 (1931). E.J.V.

Phorpres Cellular Fletton brick. LONDON BRICK CO. AND FORDERS, LTD. *Brick Clay Rec.*, **78** [2], 72 (1931).—This brick saves from 20 to 25% in weight, minimizes moisture penetration, and improves insulation of heat and sound. The sealed multicellular construction resulting affords better insulation of heat, sound, and moisture. In every 10 feet square of 9-in. wall built with cellular brick there are 3200 cells. The brick are produced plain, grooved for plastering, or with multi-colored rustic finish for facing work. Illustrated. E.J.V.

Technical and commercial coöperation in the modern brick industry. A. PULEO FAVIER. *Corriere ceram.*, **10**, 243–44 (1929). (*C.A.*)

Waste in clay manufacturing plants. H. L. LONGENECKER. *Brick Clay Rec.*, **78** [2], 84–87 (1931).—L. points out that waste in the aggregate affects the margin of profits and offers suggestions as to how this waste can be eliminated. Illustrated. E.J.V.

Fundamentals and economies in the clay industries. I. ELLIS LOVEJOY. *Clay-Worker*, **95** [1], 30–31 (1931).—In this introductory chapter L. discusses the heavy clay products business in general. E.J.V.

Future of clay products industry. C. STANLEY TAYLOR. *Brick Clay Rec.*, **78** [1], 18–22 (1931).—The building forecast indicates a year not unlike 1930. Diversified construction trends are discussed. The clay products industry does not possess thorough knowledge of the values and limitations of its own products. The industry must unite against outside competition and eliminate inner competition. E.J.V.

Development of brick. RALPH P. STODDARD. *Brick Clay Rec.*, **78** [2], 104–106 (1931).—A radio address delivered January, 1931, over the Columbia Broadcasting System, in which S. traces the historical development of the manufacture of brick through the ages, is reprinted. E.J.V.

Southern brick and tile merger controls 13 plants. ANON. *Brick Clay Rec.*, **78** [1], 14 (1931).—The Bibb Brick Co., Cherokee Brick Co., and Standard Brick & Tile Co., of Macon, Ga., the Columbus Brick & Tile Co., Jacksonville, Fla., the Georgia-Carolina Brick Co., Augusta, Ga., and the Southern Brick & Tile Co., consolidated and now operate 13 plants. They produce face and common brick, hollow tile, Jumbo brick, drain tile, DuBrick, and turpentine cups. E.J.V.

Daily News Bldg., New York. JOHN MEAD HOWELLS AND RAYMOND M. HOOD. *Metal Arts*, pp. 321–25 (Sept., 1930).—Glazed white brick is used in the construction of this building. (*D.I.*)

Swedish standard specifications for light brick. ANON. *Tegel*, **20** [11], 82–85 (1930); *Tonind.-Ztg.*, **55** [3], 46 (1931).—Data on the standard specifications for light, porous, and nonporous brick used in Sweden are given. M.V.K.

Brick industry in Italy, its origin and development. MICHELE BAVARO. *Corriere ceram.*, **10**, 187 (1929). (*C.A.*)

BOOKS AND PAMPHLET

Clay Products Manual. NORMAN W. KELCH AND M. C. POULSEN. Clay Products Institute of California, Los Angeles, Calif. Price $3.00. Reviewed in *Brick Clay Rec.*, **78** [2], 94 (1931); *Clay-Worker*, **95** [1], 58 (1931).—This book contains useful information regarding the uses and merits of the following fireclay products: common, face, fire, paving, and sewer brick, vitrified sewer pipe and liners, vitrified segmental blocks, loadbearing, partition, roof, and drain tile, terra cotta, flue linings, fireclay vents, chimney pipe, and patent chimneys, as well as considerable new data obtained in connection with research work carried on by the Institute. E.J.V.

Recommended Minimum Requirements for Structural Clay Hollow Tile Construction. F. E. EMERY. Reviewed in *Brick Clay Rec.*, **78** [2], 82 (1931).—This pamphlet contains the A.S.T.M.'s latest standard specifications governing the manufacture and tests of structural clay hollow tile, many definitions of terms, and tabular data on designing, estimating, and construction. Illustrated. E.J.V.

How to Judge a House. NATIONAL COMMITTEE ON WOOD UTILIZATION OF THE DEPT. OF COMMERCE. 84 pp. 10¢ a single copy, $7.00 a hundred, and $50.00 a thousand copies. Government Printing Office, Superintendent of Documents, Washington, D. C. This book outlines the more important considerations in regard to structural features of the average house and its planning and design. It sets forth short cuts to economy without sacrificing good construction and design.

PATENTS

Tile-making machine. ALFRED W. SCHULTZ. U. S. 1,788,638, Jan. 13, 1931. In a tile machine, an open-end hollow mold, a former head movable into and out of the mold through its open lower end, a hopper seated upon the mold to deliver thereinto, means connected to the hopper to move it to and from the mold, a deflector head within the mold and of less width than a tile to be formed therein, and positioned above the former head, an operating arm linked to the deflector head to shift the latter into and out of the mold, and means for limiting the scope of movement of the deflector head and arm, the deflector head being adapted to deflect entering material to the interspace of the mold and former head and to be moved upwardly with the upward progress of the former head by pressure of the latter upon intervening material.

Brick-roughening machine. ROBERT D. LINDSAY. U. S. 1,788,725, Jan. 13, 1931. A machine for roughening the surface of pressed brick comprising, in combination, a supporting surface, means for moving brick along the surface, means for moistening the upper surface of the brick, a plurality of scribers, and means for holding them in such a position that they will come into contact with the brick as the latter move past the scribers.

Handling unfired clay pipes. WALTER H. MAYHEW. U. S. 1,790,276, Jan. 27, 1931. Pipe-inverting apparatus including a framework of cubical form open on one side, trunnioned on a horizontal axis midway its length and adapted to swing between opposite positions in which it stands vertically and open in one or the other of two opposite directions, its center of gravity being remote from the trunnion axis in direction toward such open side.

Refractories

High-temperature heat insulating material. ANON. *Fuels & Fur.*, **8** [9], 1298 (1930).—A new insulating material of a special form of alumina is now being marketed. It can be subjected to temperatures up to 2000°F. It has no grain and gives equal resistance to heat flow in any direction. This material is intended for use in heat-treating furnaces for annealing high-grade steel, electric furnaces for enameling, heat exchangers in the steel industry, ceramic kilns, in the brick settings of boiler fire boxes, etc. A.E.R.W.

New refractory—magnesidon. ANON. *Blast Fur. Steel Plant*, **19** [1], 162 (1931).—Magnesidon has a high softening point, immunity to basic and semibasic slags and metal vapors, resistance to abrasion at high temperatures, nonspalling property, and is suitable as lining material where extensive water cooling is required. Magnesidon contains 95 to 98% magnesia, has a melting point over 5000°F, a specific gravity of 2.7 to 2.8, a softening point of 3020°F with a collapsing point of 3272°F, a uniform expansion with rising temperature, constant volume, a water absorption of about 7% by weight, and great crushing strength and resistance against temperature changes. Because of these properties magnesidon represents a refractory material of superior qualities and is especially suited for furnaces where high temperatures and most severe operating conditions have to be met. E.J.V.

Refractories in brick kilns. ANON. *Tonind.-Ztg.*, **55** [1], 3–4 (1931).—It is shown that the greater resistance and durability of grog blocks in crowns and firing channels in brick kilns make them more advantageous than brick although their original cost is higher. M.V.K.

Russian and Slovakian magnesite. E. DWORZAK. *Feuerfest*, **6** [10], 145–50 (1930).—D. discusses the use of magnesite blocks and fired magnesite, their origin and chemical composition, and compares the Slovakian (Austrian) and Russian magnesite with reference to their composition, color, and mechanical properties, *i.e.*, specific gravity, porosity, capability of absorption of water, resistance to pressure, resistance to strokes (brittleness), Seger cone, deformation under pressure, resistance to the action of slag, stability to temperature changes, properties of Slovakian and Russian fired magnesite (sintered magnesite), granulation, chemical analyses, and capability of sintering. M.V.K.

Silica blocks in Japan. PHILIPP. *Feuerfest*, **6** [8], 118–19 (1930).—Two kinds of silica blocks are made in Japan, the "Dairen" and the "Akashiro" blocks. The Dairen silica blocks are made from the South Manchurian quartzite which is hard, solid, and of yellowish color. The quartzite found contains admixtures of muscovite, limonite, magnetite, kaolin, and hornblende; blocks prepared from it are not of very

high quality and cannot be used for steel melting kilns. The Akashiro natural quartzite is an excellent material for silica blocks. The Akashiro natural rocks consist of crypto-crystalline quartz with a low content of hematite coloring it red. The Akashiro silica blocks are used in crowns of Siemens-Martin kilns and have a durability of about 450 charges. The chemical composition and properties of the Dairen and Akashiro silica blocks are given. M.V.K.

Action of gases on refractory blocks in kilns heated with cane sugar straw and coffee shells. FRED W. FREISE. *Feuerfest*, **6** [10], 150–52 (1930).—Gases from furnaces fed with "bagasse" or cane sugar straw and coffee shells are rich in potassium hydroxide which injures the acid masonry of boilers. Blocks containing less than 50% alumina are soon destroyed; therefore the boilers must be lined with blocks containing at least 60% alumina. Zirconium blocks are not advantageous, but filling the joints between the blocks with zirconium powder mixed with water glass, or coating the block surface which is directly affected by fire gases gives very good results. Tables with observations on different refractory materials are given. M.V.K.

Refractory lining in cupola furnaces. JOSEF ROBITSCHEK. *Feuerfest*, **6** [8], 113–18 (1930).—The action of slag on refractory blocks in cupola furnaces was tested according to the methods of Hartmann. In 87 cases, the behavior of the refractories corresponded to their behavior in practice. Contradictions found in 13 cases were due to the differences in working conditions in laboratory and industry. In five cases the reasons for the destruction of the refractories were found and the errors corrected by further tests. These investigations were made to prove that refractory materials used as linings in cupola furnaces are chiefly destroyed by the chemical and mechanical action of slag and that all other factors are negligible. This hypothesis was confirmed by the results of investigations although some observations showed that, in special cases, the life of a lining in cupola furnaces depends on their resistance to thermal shocks and not to their resistance to the action of slag. M.V.K.

High-refractory compositions employed in manufacture of laboratory utensils. ROBERT SCHWARZ. *Chem. & Ind.*, **49**, 271–72 (1930).—Marquardt, Pythagoras, S. K. D., silicon carbide, and "Silkarbal" ware are described. Allusion is also made to the small-scale production of crucibles of pure ZrO_2, MgO, Al_2O_3, and $MgO{\cdot}Al_2O_3$. H.H.S.

Highly-refractory materials from silicon carbide. W. RUPPMANN. *Puromentztg.*, **2** [3], 4–8 (1930); *Feuerfest*, **6** [8], 124 (1930).—The main advantages of silicon carbide blocks over grog blocks, and their use in muffle kilns for enameling, hardening on kilns, glass cooling kilns, etc., are discussed. Appropriate composition of blocks, their lifetime, and economy of fuel are given. M.V.K.

Highly-refractory Haldenwanger masses. W. HALDENWANGER. *Achema-Jahrbuch*, pp. 147–48 (1928–30); *Feuerfest*, **6** [9], 141 (1930).—A description of gas-tight Pythagoras masses and porous sillimanite masses with their special properties and uses is given. M.V.K.

Refractory materials. RIVIÉRE. *Jour. usines gaz*, **54** [9], 197–98 (1930); *Feuerfest*, **6** [8], 123 (1930).—The composition of refractory materials of clay and aggregates, their preparation, changes taking place on firing, and their properties are discussed. The difference between grog and silica materials is made clear. M.V.K.

Innovations in the preparation of refractory blocks. ANON. *Tescn. Blätter*, **20** [35], 730–32 (1930); *Stahl Eisen*, **50** [52], 1824 (1930).—A description of obtaining raw materials and the preparation of refractory blocks. M.V.K.

Raw materials and properties of refractory blocks. H. HEER. *Ofenbau*, **14** [4], 66–70 (1930); *Feuerfest*, **6** [8], 123 (1930).—This survey treats (1) the origin of kaolin and clay, (2) the character of basic metal oxides and acid nonmetal oxides, (3) basic

and acid refractory and highly-refractory blocks, (4) their behavior in basic and acid atmospheres, and (5) their resistance to variations of temperature and the action of slag. M.V.K.

Refractory natural rocks for industrial kilns. H. KALPERS. *Giess*, **17** [43], 1045–47 (1930); *Stahl Eisen*, **50** [52], 1824 (1930).—K. describes (1) the composition of refractory natural rocks; (2) their fusing temperature; (3) behavior of natural rocks under pressure with increased temperatures; (4) determining the permanent change in length; (5) stability with changes of temperature; (6) resistance of natural rocks to the action of slag; (7) structure of the rocks; and (8) behavior in operation. M.V.K.

Cast refractory blocks for metallurgical furnaces. ANON. *Fuels & Fur.*, **8** [4], 568 (1930).—This refractory material is made by melting selected high-aluminous, high-fusion materials in an electric furnace and pouring the resultant mobile liquid into molds of the finished shape. After annealing, the product is ready for shipment. One large forge furnace, equipped with these refractories, now in its third month of operation has had no repairs whatever and is practically in a new condition. A.E.R.W.

Casting refractories. ANON. *Brick Clay Rec.*, **78** [1], 34 (1931).—Consideration was given to two main classes of slip, *i.e.*, (1) those containing a fairly high proportion of large-grained nonplastics, such as are often used for the making of gas retorts, and (2) those in which the nonplastics are in moderately fine grains. Experiments undertaken to explore the possibility of casting horizontal fireclay gas retorts were described, the work embracing both the laboratory and the works sections. The effects of various deflocculents on the suspending power of the slip, and modifications of the blunging process were tested. Sodium silicate and sodium carbonate were used as liquefying agents in the laboratory tests and later a mixture of these two in the ratio of 2 to 1 was used as deflocculent in the large scale work. Finally retorts measuring 5 ft. x 2 ft. 4 in. x 2 ft. were cast, dried, and fired satisfactorily. Tests made in different laboratories on portions cut from a specimen showed a maximum variation of 0.8% in porosity, and a maximum difference of 0.03% in the after-contraction. This experimental work showed that, using alkaline deflocculents only, it would be possible to produce goods in many respects superior to those obtained from the same mixes, hand molded; and that when the upper limit of grog content possible with plastic pressing was reached, the casting process enabled further additions of nonplastics to be incorporated and if need be, they could be of much larger size. E.J.V.

Testing stability against slag. P. P. BUDNIKOFF. *Bldg. Materials*, No. 4, pp. 35–42 (1930); *Feuerfest*, **6** [11], 169 (1930).—B. reviews different methods for testing stability of refractory materials to the action of slag and concludes that the methods used do not represent actual working conditions in industry. The testing samples used in the investigations made by B. contained cavities which were filled with the corroding agents, *e.g.*, powdered slag or glass. Graphite electrodes were attached to the cavities and the electric current for heating could be regulated and could maintain the required temperature. This arrangement for testing the stability of refractories to the action of slag corresponds more exactly to the conditions prevailing in industry than all other methods used. M.V.K.

Influence of an addition of kaolin on the property of refractory products. P. P. BUDNIKOFF. *Ber. deut. keram. Ges.*, **11** [6], 373 (1930).—The resistance of refractory products at higher temperatures will be increased by raising the alumina content. This can be done economically by adding kaolin to grog products. Kaolin will increase the resistance against basic slag. At two ceramic plants different experiments on the influence of kaolin addition on raw products have been made showing that

resistance against load was improved. Some believe that an addition of kaolin would increase the after-shrinkage of the products during use and that kaolin additions are not suitable for metallurgical purposes. The research laboratory of the plants, however, tested grog brick with and without addition of kaolin. Samples from shaped brick were fired at 1420°, 1500°, and 1590°. The results are given in a table and it can be seen that brick made of Tschassoff-Jar clay has a shrinkage at 1500°. Brick with addition of kaolin has a much smaller shrinkage. Grog brick with an addition of kaolin did not only become richer in alumina but their refractoriness was raised, and if the firing is done properly an after-shrinkage will not occur. I.R.

Thermal expansion of silica brick. BERNARD LONG. *Céramique*, **33** [512], 268–72 (1930).—(1) *Manufacture.* L. outlines the manufacture of lime-bonded silica brick and states that the object of firing is to form a calcium silicate bond and to transform quartz into tridymite and cristobalite. The proportion of quartz in the finished product is generally small. Fused silica is sometimes said to be present in small amounts. (2) *Expansion of tridymite and cristobalite.* The thermal expansion curves of quartz, tridymite, and cristobalite are compared and the effect of the reversible inversions pointed out. (3) *Expansion to 600°C.* Thermal expansion curves of silica brick to 600°C are discussed. Their use in estimating tridymite, cristobalite, and quartz, in controlling the firing of brick, and as a guide in heating furnaces of silica brick is pointed out. (4) *Expansion from 600 to 1500°C.* With underfired brick, a rapid increase in expansion is found at about 1400°C due to the change of quartz to tridymite and cristobalite. (5) *Apparatus.* The Chevenard dilatometer with mechanical registration, the Pellin with photographic registration, and an apparatus in which two telescopes are trained on scratches on platinum riders are described. (6) *Data.* Curves obtained with the three kinds of apparatus are given for brick whose true specific gravities were known. A case is presented in which the anomalies in the curves are not in proportion to the cristobalite and quartz present. A.E.R.W.

Spalling tests of fireclay brick. ANON. Bur. Stand., *Tech. News Bull.*, No. 165, pp. 2–3 (1931).—Two methods of testing the resistance of fireclay brick to thermal shock are recognized at present. One of the methods was promulgated by the A.S.T.M. and the other by the Federal Government. Because of the cost and confusion resulting from such a condition, the Federal Government has made a series of comparative spalling tests on 22 brands of fireclay brick to determine whether it was desirable to make changes in the present Federal specifications for fireclay brick. The maximum, minimum, and average number of cycles to cause spalling obtained when tested by five different methods of test are given. R.A.H.

Checker brick deterioration. R. M. KING. *Blast Fur. Steel Plant*, **19** [1], 114–17 (1931).—A close examination of a setting that had failed and the chamber in which it was housed showed that (1) the setting had fused and sunk in the middle and the fused mass had flowed against the bulkhead; (2) each side of the setting remained at approximately its original height; (3) the fused area seemed to center about the third course from the top; (4) except for those in the center of the fused zone and those covered with slag, the checkers themselves were in good condition. Remarkably few were badly deformed. Fractures showed normal brick structure, color, and approximately normal cross-sectional area. On the top course the slag had coated the block from a quarter to one-half inch in thickness, but had not penetrated the interior. A fusion determination on a sample of the clean brick of normal color and structure gave a P.C.E. value of 31. A brick from the second course also had normal color and structure and very little slag on its surface. Its P.C.E. was 31. The brick of the third course all the way through the setting showed, when broken, a mixed red and black color. A fusion test on a typical brick sample gave P.C.E. 19 to 23. (5)

An analysis of the slag on the top of the checker gave SiO_2, 16.30%; FeO, 63.31%; Al_2O_3, 12.96%; MnO, 0.39%; CaO, 3.02%; MgO, 0.79%; Cr_2O_3, 0.35%. This slag caused sticking of the brick for several courses down. The P.C.E. of this slag was 12. From facts obtained, the conclusion as to the cause of the failure is that it was partly built of low-refractory previously-used checker brick. Illustrated. E.J.V.

High pressure improves quality of refractories. J. OTIS EVERHART. *Brick Clay Rec.*, **78** [2], 100 (1931).—In checking the properties of brick pressed at fairly high pressures, from 2500 to 5000 lb./sq. in., in both hydraulic and mechanical presses, very little difference was found in the properties of the brick. The limit of pressures available is sufficient for high-pressure work on refractories. Cracking with high pressures can be eliminated by evacuating the mold and by lengthening the pressure cycle. E.J.V.

Dissociation of carbonic oxides in contact with refractory materials. W. D. HUBBARD AND W. J. REES. *Trans. Ceram. Soc.* [Eng.], **28** [6], 277–307 (1929); *Tonind.-Ztg.*, **54** [1], 17 (1930); for abstract see *Ceram. Abs.*, **8** [11], 816 (1929). M.V.K.

Fire clays: some fundamental properties at several temperatures. R. A. HEINDL AND W. L. PENDERGAST. Reviewed in *Brick Clay Rec.*, **78** [1], 22 (1931); see also *Ceram. Abs.*, **10** [1], 42 (1931). E.J.V.

Refractories at high temperatures. BERNARD LONG. *Refrac. Jour.*, **5** [59], 424 (1930); see also *Ceram. Abs.*, **9** [12], 1053 (1930). E.P.R.

Testing equipment for refractory materials. L. LITINSKY. *Ceram. Age*, **15** [6], 363–66; **16** [2], 109–13; [3], 170–75; [4], 234–38; [6], 332–35 (1930); see also *Ceram. Abs.*, **10** [2], 126 (1931). A.E.R.W.

Preventing pressure cracks in dry-press refractories. ANON. *Fuels & Fur.*, **8** [9], 1246 (1930); for abstract see *Ceram. Abs.*, **9** [9], 746 (1930). A.E.R.W.

Fusion diagrams of highly-refractory oxides. II. H. v. WARTENBERG AND H. WERTH. *Sprechsaal*, **63** [39], 746 (1930); for abstract see *Ceram. Abs.*, **9** [11], 941 (1930). M.V.K.

Progress in English refractory industry. W. STEGER. *Feuerfest*, **6** [9], 129–33 (1930).—S. reviews the progress of the English refractory industry in 1929 discussing (1) drying cracks in fire brick; (2) dissociation of carbon monoxide in contact with refractory materials; (3) substitution of quartzite powder in silica raw pastes by quartz sand; (4) refractory blocks for regenerators; (5) refractory materials for gasworks; (6) refractory formers for electric heating elements; and (7) jointing cements. M.V.K.

Activities of the scientific division of the Union of German Refractory Industry. W. MIEHR. *Tonind.-Ztg.*, **54** [104], 1597–99 (1930).—M. reviews the work of the scientific division of the Union of German factories for refractory objects in 1929–30 on (1) resistance to the action of slag, (2) specific gravity, volume, and porosity, (3) thermal conductivity, (4) chemical analyses, (5) softening under pressure, reversible and constant dimensional change, (6) microscopical investigations on raw materials, resistance to temperature changes, (7) resistance to pressure at room temperature, (8) molding, and (9) acid stability. M.V.K.

"Weta" fireproof ware. ANON. *Sci. Amer.*, **141**, 547 (1929); for abstract see *Ceram. Abs.*, **8** [10], 749 (1929). H.H.S.

Chrome ore cement used in laying up hearths for annealing furnaces. ANON. *Fuels & Fur.*, **8** [9], 1246 (1930).—A forge company is using a multi-bond chrome ore base cement in laying up the hearths of seven car-type annealing furnaces. Two-course hearths of brick are supported on the cars in a shallow rectangular frame. The first course is of common red 9-in. straights and the second course of good quality fire brick is laid directly over the first with the chrome ore cement. A.E.R.W.

Chrome ore imports. ANON. *Chem. & Ind.*, **49**, 399 (1930).—Imports into the U.S. in 1929 totaled 317,630 T., an increase of 46.7% over 1928, showing the growing demand for Cr for general use which has been in evidence since 1922. Rhodesia, Cuba, New Caledonia, and Greece provided 86% of the imports, the remainder coming mainly from India and S. Africa. H.H.S.

Bauxite deposits of the Rhone Delta. V. CHARRIN. *Génie civil*, **94**, 258–60 (1929).—Maps and description of geological features are given. (*C.A.*)

PATENTS

Sectional furnace wall. DAVID S. JACOBUS AND NATHAN E. LEWIS. U. S. 1,789,074, Jan. 13, 1931. In a furnace wall, a plurality of supporting members, a casing supported by the members, a plurality of plates spaced from the members and casing, means independently supporting each plate from the members, and means on each plate to hold tile thereon.

Refractory article and furnace lining made therefrom. RAYMOND C. BENNER AND GEORGE J. EASTER. U. S. 1,789,131, Jan. 13, 1931. A furnace lining comprised of refractory blocks which have been pressed in a direction perpendicular to the plane of the exposed faces of the blocks.

Grooved refractory lining. HARRY R. ORWICK AND EDWIN J. BOGNAR. U. S. 1,789,474, Jan. 20, 1931. A refractory lining consisting of a cylindrical body portion and a cover therefor, the body portion having an open end provided with an annular groove, a closed centrally apertured end, and an aperture in its wall, the body portion having also interior parallel dovetailed grooves, the closed apertured end having interior dovetailed radial grooves connecting with the parallel grooves at the circumference of the closed end, and the cover having an annular flange adapted to enter the annular groove in the open end of the body portion and being provided with radial dovetailed grooves and a central opening, the grooves being adapted to receive and retain a moldable mixture.

Removing iron from materials. WILHELM GAUS. U. S. 1,789,813, Jan. 20, 1931. The process for removing iron from bauxite containing iron, which comprises acting on the bauxite with water gas at a temperature of about 250°C and a pressure of about 100 atmospheres and removing the iron carbonyl formed.

Making silicon carbide refractory articles. MINER L. HARTMANN. U. S. 1,790,474, Jan. 27, 1931. The method of treating commercial silicon carbide to increase its resistivity to oxidizing conditions at high temperatures which comprises effecting the removal from the silicon carbide of the inherent compounds of easily reducible metals falling below manganese in the electro-chemical series and capable of accelerating the oxidation of silicon carbide at high temperature, mixing the grains with a bond containing kaolin clay and feldspar, which is also free of the catalytic materials and which is capable of reducing the permeability of the article to penetration by oxidizing gases, and firing the shaped form.

Producing ceramic vessels. MAX HAUSER. U. S. 1,790,918, Feb. 3, 1931. The process of making ceramic vessels having toughness and high heat conductivity which includes mixing a ceramic raw material and a chromium alloy, shaping the mixture to the desired form, and firing.

Manufacturing briquets from clay, sulphite liquor, and carbonaceous material. LUDWIG WEBER. U. S. 1,791,077, Feb. 3, 1931. In a method of manufacturing briquets, the steps which comprise mixing a finely divided clay of great plasticity with the particles to be briquetted, and moistening the mixture of clay and the material to be briquetted with sulphite waste liquor.

Furnace wall. OSCAR NYGAARD. U. S. 1,791,244, Feb. 3, 1931. In a furnace

wall, the combination of a series of supports and brick substantially covering the entire widths of the supports at the fire side of the wall to protect the supports, the brick each having a groove extending substantially the length of the brick and shaped to contact with a support over a substantial portion of the groove surface, the brick having an interlocking engagement with each other and with the supports and being held in their operative positions by the engagement.

Recovery of refractory metals from ores. CHARLES V. IREDELL. U. S. 1,791,272, Feb. 3, 1931. The method of decomposing rare metal silicate ores which comprises heating the silicate ore with carbon to elevated temperatures sufficient to effect conversion of the silicon and the rare metal content to carbide compounds.

Production of aluminium salts. COLLOID-CHEM. FORSCHUNGS A.-G. Brit. 336,181, Dec. 3, 1930. In the acid process for extracting aluminium, the difficulty in recovering iron-free aluminium salts from the mother liquor is overcome by adding 96% alcohol. The almost pure aluminium sulphate, which is precipitated, is dissolved in water and reprecipitated with alcohol. (*B.C.A.*)

Purification of graphites. E. RABETRANO. Brit. 337,738, Dec. 31, 1930. Graphite in minerals of low carbon content is separated from silica, silicates, oxides of iron, etc., by fractional precipitation in a liquid containing a colloid, the fraction containing the graphite being afterward subjected to electro-osmotic action in a vessel in which the settlement of all the particles in suspension is retarded either mechanically or by the presence of a colloid or by both methods simultaneously. The mineral, ground and roughly purified by centrifugal action and decantation, is suspended in a liquid, preferably water, to which is added a colloid to increase the viscosity of the liquid, such as dextrine, alumina, saponin, gelatine, or potassium silicate.

Furnaces. BABCOCK & WILCOX, LTD. Brit. 339,055, Jan. 21, 1931. Blocks for furnace walls, comprising a metallic portion engaging with water tubes and a refractory portion held in a recess in the metallic portion, have the recess in the metallic portion formed by flanges, the inner surfaces of which converge outwardly. The refractory portion is formed with an extension with diverging walls to correspond with the recess, the shortest distance between the flanges being less than the greatest width of the extension. The two portions are held together by cement formed, *e.g.*, of clay and waterglass.

Furnaces. SOUTH METROPOLITAN GAS CO. AND W. T. SEACH. Brit. 339,268, Jan. 28, 1931. In brickwork or other refractory material of retort settings, furnaces, etc., in which gaps for expansion are provided between adjacent brick, the gaps are closed by strips of metal in slots formed in opposite faces of adjacent brick near the front of the gap. Mill board may be used in conjunction with two strips of metal.

Ceramic magnesium and lime magnesium masses. VEREIN CHEM. METAL. PRODUCTION. *Feuerfest*, **6** [8], 120 (1930); for abstract see *Ceram. Abs.*, **9** [5], 331 (1930). M.V.K.

Terra Cotta

Coördination of various ingredients in the manufacture of terra cotta. H. SPURRIER. *Fuels & Fur.*, **8** [8], 1111–14 (1930).—S. gives curves to show the effect on shrinkage and water loss of additions of silica and of alumina to a given clay. He shows by these curves that a coarser silica does not retain the water as persistently as the finer grading does and is, therefore, not so dangerous. Care must be exercised to insure a body against too great a free silica content particularly if the free silica is in a fine state of subdivision. Other curves show the effect on shrinkage and water loss of additions

of various quantities of arenaceous clay to the same base clay. A 20% addition has less effect in shrinkage than 15%. Electrolytes affect the shrinkage and water loss of the body. In the cases of salt and ammonium hydrate, the minimum additions gave the maximum results. As the character of clay used in a body has an important bearing on the amount, grading, etc., of grog, no hard and fast specification for grog can be set forth. These rules should be followed: (1) It is desirable to carry as much grog as possible but not sufficient to cause cracking. (2) A rough texture will result if there is not sufficient plastic material. (3) The best grog is one made from the same clay or clays that constitute the plastic portions and which has been subjected to the same thermal treatment. (4) Care should be taken that there are no pieces of colored glaze in the grog. (5) There should be some control of the proportions of the different sizes of grog. There are several methods of mixing the clay and grog. One satisfactory means is by the "disk feeder." From the feeder the clay and grog pass into a mixer. During this process the anti-scumming agents are also added. These are usually small amounts of barium carbonate and barium hydrate. The mixture discharges its burden into a pug mill which further mixes and homogenizes the body. A device has been worked out designed to adjust the proper water addition irrespective of the original amount of water in the raw materials. See also *Ceram. Abs.*, **10** [2], 127 (1931). A.E.R.W.

Glazing new pots. F. SCHUR. *Glashütte*, **60** [30], 548 (1930); *Feuerfest*, **6** [10], 156 (1930).—Three different methods tested in practice for glazing pots are described. M.V.K.

Lightweight construction in modern buildings. ARTHUR D. LITTLE. *Brick Clay Rec.*, **78** [2], 90 (1931).—The tendency in modern skyscraper construction to save weight which is primarily reflected in lower costs both for foundations and for the skeleton of the buildings is discussed. E.J.V.

Architectural acoustics. R. A. LIPPINCOTT. *Jour. N. Z. Inst. Arch.*, **9**, 73–78 (1930).—Sound absorption depends on discontinuity of materials, *e.g.*, voids in one material, or an alternation of two materials such as sheet iron and felt. H.H.S.

British standard specification for clay or marl plain roofing tile. BRITISH ENGINEERING STANDARDS ASSN. *Brit. Clayworker*, **39** [465], 373–75 (1931).—These specifications cover (1) description, (2) manufacture, (3) color, (4) nibs, (5) size, (6) thickness, (7) camber, (8) nail holes, (9) transverse test, (10) freezing test, and (11) permeability test. The methods of carrying out the tests and a description of the apparatus are included. R.A.H.

Modern shops. ANON. *Good Furniture & Dec.*, pp. 267–72 (Nov., 1930).—Interiors of several modern shops and studios are described and illustrated. (*D.I.*)

Modernistic vs. traditional architecture. WILLIAM ORR LUDLOW. *Southern Arch. & Bldg. News*, p. 49 (Dec., 1930).—L. states that new materials, new methods of building, and new housing requirements change both architecture and construction. (*D.I.*)

BOOKS

Modern Architectural Sculpture. Edited by W. AUMONIER. Scribner's, New York, 1930. Price $20.00. This book shows the whole range of architectural sculpture of every type that has been executed during the last few years. The U.S. and most of the European countries are represented. Illustrated. (*D.I.*)

Wie Baut Amerika. RICHARD J. NEUTRA. Hoffmann, Stuttgart, 1927. Price about $2.75. Skyscrapers, railway stations, houses, prisons, etc., show the contribution of the U.S. to modern architecture. (*D.I.*)

White Wares

Influence of time on maturing temperature of whiteware bodies. I. F. H. NORTON AND F. B. HODGDON. *Jour. Amer. Ceram. Soc.*, **14** [3], 177–91 (1931).—In this investigation, quantitative relations have been established between the time and temperature effects in the maturing of whiteware bodies. Six typical commercial whiteware bodies were used. Similar shrinkage and porosity curves were obtained for different firing times but the longer the time the lower the curve was shifted on the temperature scale. It was found that in all cases the usual logarithmic law relating temperature with the rate of reaction applied. The constant, however, was not the same for all bodies. The microstructures of these bodies are dealt with in Part II of this paper. **II.** CHARLES L. NORTON, JR. *Ibid.*, **14** [3], 192–206 (1931).—This investigation deals with the microscopic examination of three of the whiteware bodies which were described in Part I of this paper. With respect to the influence of time of firing upon the crystalline texture, it was found that with samples which showed the same degree of maturity by physical test, the long-fired, low-temperature samples showed more quartz solution as well as more mullite development than the samples fired more quickly at higher temperatures.

Effects of autoclave treatments on ceramic bodies and clays. H. H. HOLSCHER. *Jour. Amer. Ceram. Soc.*, **14** [3], 207–18 (1931).—It has been found that porous ceramic bodies increase in volume and weight due to an autoclave treatment in which the ware is subjected to steam at a pressure of 150 pounds per square inch. The change is rapid at first but decreases as the time of treatment is increased. Typical American and English china clays also increase in volume but ball clays when fired to the same temperature as the china clays do not increase in volume. The effect of prolonged drying treatments after the autoclave treatment is also studied. Data given indicate that the changes in volume are not necessarily caused by rehydration of the clay within the body. Bodies containing clay, feldspar, and flint show a greater increase in volume than do the pure clay constituents. It is shown that the composition is a more important factor than absorption in determining the reaction of ceramic products to the autoclave treatments.

Questions regarding the manufacture of porcelain. M. LARCHEVÊQUE. *Céramique*, **33** [510], 221–24 (1930).—(1) *Cobalt in clays.* Certain black clays which fired white were found to contain Asbolane whose theoretical formula is $CoO{\cdot}2MnO_2{\cdot}4H_2O$. The white firing is explained by the presence of cobalt which neutralizes the cream color which would otherwise appear. (2) *Slips.* Good results were obtained by using sodium tannate instead of Solvay soda in deflocculating slips as follows:

Batch		
Dry, hard-porcelain paste	100 kg.	
Water	82 kg.	
Sodium hydroxide	128 g.	As alkaline solution
Tannin	104 g.	of sodium tannate.

After blunging, filter-pressing, etc., 60 to 70 g. of Solvay soda and 15 to 30 cc. of silicate of soda are added to adjust the slip. Excess of sodium silicate was found in one case to decrease mold life and to prevent sticking of the engobe. (3) *Bisque defects.* Yellow spots and shades on bisque were attributed to colloidal iron accumulating in the surface. The manufacturers were advised to use "Fluidors" or "plastinol" instead of sodium silicate or soda ash. (4) *Kiln atmospheres.* Yellowing and bloating of porcelain was at first attributed to firing in an oxidizing atmosphere in a muffle kiln, but it was pointed out that an oxidizing atmosphere has this effect only when the ware has previously been in contact with a reducing atmosphere. (5) *American*

porcelain. American porcelain and whiteware are described and the decreasing use of French porcelain in America and increasing use of American porcelain in France pointed out. A.E.R.W.

Influence of paper and wood wool on porcelain. EUGEN KILLIAS. *Keramos*, **9** [25–26], 945 (1930).—K. describes tests made to ascertain the influence of paper and wood wool on packed porcelain during long storage. Paper and wood wool always contain some free acid which dissolves out from the paper during damp storage and injures the decoration on the porcelain. Atmosphere influences wood wool and forms organic salts which also injure porcelain. It is also possible that dampness and the acids present form electromotive series of the different metals and through electrolytic disintegration ruin the gold and color layers of the porcelain. A valued porcelain service was greatly injured during 3 years storing in a dry place; the blue and gold colors changed into black spots. M.V.K.

Mammoth testing house for porcelain industry. ANON. *Ceram. Age*, **16** [4], 211 (1930).—A recent development in porcelain manufacture is the rather unique testing station at Selb, Germany, for testing electrical insulators under exceptionally high stress. The project is so extensive as to make it difficult to derive an adequate idea of the size of the equipment. To house the equipment a substantial building has been constructed in Selb, the center of one of the world's largest porcelain-producing areas. The experimental work calls for a field of 2,000,000 volts. Illustrations of mammoth insulators designed for 1,000,000 volts, and a giant transformer designed to carry the same voltage, are included. R.G.M.

Rate of vitrification of porcelain. C. W. PARMELEE AND C. BADGER. *Refrac. Jour.*, **5** [59], 424 (1930); for abstract see *Ceram. Abs.*, **10** [1], 48 (1931). E.P.R.

Progress of the high-fired porcelain industry. A. H. FESSLER. *Fuels & Fur.*, **8** [4], 547–48 (1930).—F. gives a review of the work done by physical, analytical, and geochemistry, thermochemical mineralogy, and physics in making ceramics into an exact science. A.E.R.W.

Electrical porcelain. I. J. K. GILLETT. *Electrician*, **105**, 434–36 (1930).—The mineralogical microscope makes it possible to determine the quality of the finished product and to predict its performance. The manufacture of porcelain insulators is outlined and a practical comparison of 2 commercial bodies made. Glaze and porosity are shown to affect porcelain performance. **II.** *Ibid.*, 588–89 (1930).—This instalment deals with tests for porosity, the effect of glazes on mechanical and thermal properties, and breakdowns caused by cementing. A brief bibliography is included. (*C.A.*)

National standard for testing power-line insulators. ANON. *Commercial Stand. Monthly*, **7** [6], 175 (1930).—Further protection of high-voltage electrical transmission lines which carry power at voltages as high as 220,000 was approved by the American Standards Assn. of a national standard for testing power-line insulators. Test voltage applied was increased at the rate of 10,000 volts every 15 seconds until failure occurred. The final voltage must be far above the greatest voltage which the insulator either singly or in series with other insulators will be required to withstand. It is pointed out that the suspension insulators used for cross-country transmission lines must be tested not only for their resistance to high voltages but also to the tremendous stresses set up by wind and by the ice which may cover the lines in winter, especially since the transmission towers from which the lines are suspended by means of the insulators are in some places as much as a mile apart. E.J.V.

Uses of lithium and compounds. WILLIAM T. DAUGHERTY. *Commerce Repts.*, **52**, 791 (1930).—Lithium salts are used in the ceramic industry. As porcelain is made much more resistant to sudden temperature changes by lithium additions, they are

considerably employed for insulation of ignition installations in automobile motors. Furthermore, the addition of lithium compounds has proved valuable in the production of electric high-tension porcelain. E.J.V.

Changes in volume of fired clay bodies. ANON. *Ceram. Ind.*, **15** [3], 302 (1930); for abstract see *Ceram. Abs.*, **9** [7], 544 (1930). W.W.M.

Account of the tour of inspection of the U.S. E. LABÈQUE. *Céramique*, **33** [510], 226–31 (1930).—An account is given of the visits to electrical porcelain plants in the U.S. and a comparison is made with the conditions in France. The conclusion is drawn that the French would do well to follow the American lead in standardizing products, etc., but should only adopt those parts of the American system which are suited to French conditions. A.E.R.W.

BOOK

International Competitive Situation in the Porcelain Industry. (Die internationale Konkurrenzverhältnisse in der Porzellanindustrie mit besonderer Berücksichtigung der fabrikationstechnischen Grundlage.) FRITZ RIEBER. Keramos Edition, Bamberg, 1930. 341 pp. Rm. 6.50. Reviewed in *Keramos*, **9** [25–26], 971 (1930).—R. discusses the technical principles of porcelain manufacture and describes the porcelain industry in different countries; the raw materials used, methods of production, character, requirements, objects and branches, and bases of organization. There are 4 kinds of porcelain according to the historical classification: (1) The oldest is the East Asiatic from China and Japan, (2) the Continental European, (3) the English, and (4) the American. French and German porcelain is valued for its quality and Czechoslovakia and Japanese porcelain for its cheapness. Data on the production in separate countries are given. M.V.K.

PATENTS

Insulating bushing. GEORGE A. BURNHAM. U. S. 1,788,380, Jan. 13, 1931.

Oil-filled insulating bushing. GUSTAV E. JANSSON. U. S. 1,788,395, Jan. 13, 1931.

Ceramic tile. NILS H. CEDERQUIST. U. S. 1,790,227, Jan. 27, 1931. The method of making glazed tile comprises forming a ceramic biscuit having a flat base and a crowned front face sloping toward the base, positioning the biscuit with its front face uppermost and with its surface disposed symmetrical with respect to the horizontal, fusing the vitreous material to a fluent state, and causing the fused material to flow over the front face under the action of gravity.

China spout. PHILIP MUELLER. U. S. 1,790,316, Jan. 27, 1931. In combination with a pipe, a ceramic spout, a metallic sleeve in the spout threaded for connection with the supply pipe, a gasket rotatable with the spout and engaged with the sleeve to hold the latter against rotative movement in the spout, the sleeve being adjustable on the pipe through rotation of the gasket by the spout and the sleeve serving to press the gasket against a wall of the spout when adjusted on the pipe.

China spout. PHILIP MUELLER. U. S. 1,790,317, Jan. 27, 1931. In combination with a pipe, a ceramic spout, a metallic sleeve in the spout threaded for connection with the pipe, a gasket held in the spout against rotation, the gasket serving to hold the sleeve against rotation relative to the spout and the sleeve being adjustable on the pipe through rotation of the gasket by the spout, the spout having its bore around the gasket tapering toward the rear of the spout, the gasket being forced rearwardly in the spout by the sleeve as the latter is adjusted on the pipe.

Pottery making. V. H. CRÉYKE. Brit. 338,663, Jan. 14, 1931. In the manufacture of teacups, jugs, etc., the handle, which is fired apart from the body of the vessel, is provided with a groove which, by engagement with the edge, retains the handle in position while the whole is being dipped in glaze preparatory to the glost firing, which then unites the handle solidly to the vessel.

Equipment and Apparatus

Indicating pyrometer controller. ANON. *Fuels & Fur.*, **8** [11], 1568 (1930).—A new pyrometer has been developed which can be used as an automatic control pyrometer, resistance thermometer, tachometer, or CO_2 meter. A.E.R.W.

New pyrometer temperature recorder. ANON. *Fuels & Fur.*, **8** [10], 1429–30 (1930); for abstract see *Ceram. Abs.*, 9 [12], 1073 (1930). A.E.R.W.

Simple volumenometer and its use for the determination of the porosity and of the true and apparent specific gravity of porous masses. ROLAND WASMUHT. *Chem. Fabrik*, 520–22 (1929).—The apparatus consists essentially of a graduated burette with a bulb at the top closed with a ground stopper, the bulb having a side tube with cock. The apparatus is mounted on a board pivoted at the middle so that it may be held with either end up. Working directions are given. (*C.A.*)

Will the Weather-Ometer improve clay products? HUGH E. WEIGHTMAN. *Ceram. Age*, **16** [5], 267–69 (1930).—W. proposes a tentative simulative service test for ceramic materials in order to determine in a short time the effect of service for a period of years under normal conditions. The Weather-Ometer, a device developed for use in the paint and varnish and similar trades, is able to simulate actual conditions such as light, moisture, temperature changes, and varying small incidental additions to normal air, at a much faster rate than these conditions actually occur. Illustrated. R.G.M.

Micromanometer of high sensitivity. E. OWER. *Phil. Mag.*, **10** [65], 544–51 (1930).—An instrument is described by which air flow can be measured from 20 ft./sec. downward. At 2 ft./sec. accuracy of 1% can be attained. The chief use of the instrument is as a laboratory standard for the calibration of other anemometers. M.A.E.

Porosity measurement by the Gurley densiometer. ANON. *Instrument World*, **3**, 165–66 (1930).—The densiometer constructed by W. & L. E. Gurley of New York measures porosity by the volume of air which is forced through a given area of the sample under pressure from a cylinder containing a head of oil. H.H.S.

Measurement and recording in the factory. ANON. *Chem. & Ind.*, Supp. No. 49*S*, pp. 1–32 (1929).—Sixty-six firms describe their various meters and there is a classified index of the apparatus. H.H.S.

New lamp discovers strain in glassware. ANON. *Popular Sci.*, **118** [3], 72 (1931).—A German lamp has been devised for use in inspecting glass objects for traces of strain before they leave the factory. The lamp produces polarized light, in which strained pieces of glass, ordinarily transparent, cast a shadow. Illustrated. E.J.V.

Instrument for detecting metallic bodies buried in the earth. THEODORE THEODORSEN. *Jour. Frank. Inst.*, **210** [3], 311–26 (1930).—A cylindrical wooden frame supports a central power coil and two opposing pick-up coils in loose magnetic coupling with it. The pick-up coils supply a telephone. In such sensitive detectors it is necessary to avoid capacity and resistance effects. M.A.E.

Ball mill studies. A. W. FAHRENWALD AND HAROLD E. LEE. *Mining & Met.*, **12** [290], 24 (1931).—The results of an extensive experimental study of the numerous elements entering into ball-mill grinding are presented. All apparatus used was equipped with ball bearings. Every experiment was accompanied by a power measurement accurate to 0.005 h.p. Quartz was used. Each element studied, such as ball load, was varied systematically. Power curves were obtained for the mill for three general sets of conditions, *i.e.*, (1) balls only, (2) balls and quartz, and (3) balls, quartz, and water. For each general condition power curves were obtained for various mill speeds, ball loads, and ball sizes. For conditions 2 and 3, feed size and weight and pulp dilution

also were studied as variables. The mill output, in grams of finished product per unit of time, was obtained for each test. In a general way, output (mill capacity) paralleled the power data and this attached much interest to optimum points on the power curves. Viscosity, angle of nip, and circulating load also were considered. E.J.V.

V-belt sheaves should be accurate. R. E. S. GEARE. *Abrasive Ind.*, **12** [2], 41–42 (1931); for abstract see *Ceram. Abs.*, **10** [2], 132 (1931). E.P.R.

Tool steels in the ceramic industries. H. L. HARRISON. *Ceram. Age*, **16** [6], 321–23 (1930).—After commenting on the different types of steels, H. points out that cobalt chromium steel shows the greatest tendency to resist abrasion and this makes it especially useful for pulverizing hammers, dust-mill blades, augers and mixing paddles for pug-mill, scrapping blades, etc. Higher initial price is compensated by the economic advantages of much longer life. A.E.R.W.

Segmental crucibles for induction furnaces. ANON. *Fuels & Fur.*, **8** [12], 1685–86 (1930).—These crucibles are constructed of a number of tongued and grooved sections of tile, cemented together. The crucible is set into the furnace coil and the intermediate space between it and the coil is then packed with mica or asbestos paper. The inside of the crucible has a rammed lining of crucible cement. By repairing or renewing the cement lining every 10 to 15 melts, it is possible to obtain 150 to 200 melts from one crucible. A.E.R.W.

Interchangeable ground-glass joints. COMMERCIAL STANDARD CS21–30. *Commercial Stand. Monthly*, **7** [5], 133 (1930).—This commercial standard governs the taper, diameter, and length of ground-glass joints, so that the product of one manufacturer may be completely interchangeable with that of another. E.J.V.

Obsolescence and anti-friction bearings. A. K. WEST. *Brick Clay Rec.*, **78** [2], 88–90 (1931).—Anti-friction bearings cut production and upkeep costs and effect obsolescence. Comparison is made of roller-bearing equipped machines with plain-bearing machines on the basis of power consumption, cost of lubrication, and upkeep costs. The connection between obsolescence and anti-frictionizing is explained and discussed in detail. E.J.V.

Fundamentals in humidity control. W. F. SCHAPHORST. *Brick Clay Rec.*, **78** [2], 98–100 (1931).—The effect of heat and cold on saturated air is explained, using simple illustrations to make the various points clear. The effect of evaporation on temperature is discussed, as is the use of a wet- and dry-bulb thermometer for determining the relative humidity. E.J.V.

New lamp reflector imitates daylight. ANON. *Popular Sci.*, **118** [2], 74 (1931).—A new reflector that can be slipped onto any lamp adds to lighting comfort by imitating daylight. Its blue-glass mirrors distribute a soft white light, said to be easier on the eyes than the glare of ordinary bulbs and pleasanter to read by as it filters out the bulb's yellow rays. Illustrated. E.J.V.

New microscope uses invisible light. ANON. *Popular Sci.*, **118** [2], 52 (1931).—A new way to take photomicrographs by invisible ultra-violet rays makes it possible to use ordinary glass lenses in the microscope. E.J.V.

Mechanical handling of raw and manufactured material in glassworks. T. E. DIMBLEBY. *Jour. Soc. Glass Tech.*, **14** [55], 263–80 (1930).—The discussion includes the various types of equipment for handling of material in glass plants. The paper is well illustrated with diagrams and photographs. G.R.S.

Mechanical handling developments in the brick industry. W. H. A. *Brit. Clayworker*, **39** [465], 385–90 (1931).—The manufacture of brick by mechanical devices, *e.g.*, the steam or electric navvy, steam or electric excavators, or steam or electric planers, depending on the nature of the mines, is discussed. The clay is delivered into tip

wagons drawn up an incline into a building housing provided with storage towers having reciprocating sloping floors to give continuous feed to the grinding pans, to rotary screens by bucket elevators, then to the mixing and distributing conveyer, to storage hoppers, and on to the presses. The article describes the various types of equipment in detail. R.A.H.

Morris versatile power crane. J. L. MILLER. *Can. Eng.*, **60** [3], 19–20 (1931).—The runabout crane will travel in any direction and handle a load with no variation in stability factor. The front wheels are each independently motor driven. Diagrams show its versatility of action. G.R.S.

Beryllium and its alloys. W. ROSENHAIN. *Engineering*, **128,** 813 (1929).—The strength weight ratio of Be is 2 to 3 times that of duralumin. It resists corrosion, a polished specimen having remained bright in a chemical laboratory for years. The cost is still high but new sources of Be ore are constantly being discovered. Addition of 3% Be to copper greatly increases the elastic modulus of Cu. H.H.S.

Measuring the drying of clays and of ceramic materials. P. FRION. *Céramique*, **33** [509], 192–95 (1930).—F. points out the distinction between shrinkage and pore water and that it is in the first stage of drying when shrinkage is taking place that damage is apt to occur. Having found that methods based on loss in weight were inconvenient for following the course of drying, the "Pinette" retractometer was developed. This apparatus recorded the shrinkage of a strip of the material under test. A straight bar provided with a knife edge at one end and a toothed roll at the other is placed on the material. When the material shrinks, the toothed roll turns, winding up a string which by a system of pulleys moves a pen on a rotating cylinder. Once a correct shrinkage curve is established for a material, the retractometer is a valuable aid in controlling the drying of that material. A.E.R.W.

Heating and airing of brick drying installations. K. O. SCHULZ. *Tonind.-Ztg.*, **55** [2], 23–25 (1931).—Heating and airing are the chief considerations in an artificial drying installation. The quantity of heat required for drying ware depends on the water content of the ware, the nature of raw materials used for its preparation, and manufacturing process. Sources of heat for drying installations are (1) waste steam and fresh steam from the boiler, (2) hot air obtained from air condensation of waste steam and from pipes heated by flue gases, (3) heat from the cooling chamber of the annular kiln, (4) flue gases from the boiler and firing kiln, and (5) heat radiated from the annular kiln. It is important to regulate the heating of the drying installation according to the sensitiveness of ware. The method of using the heat from the cooling charge of the annular kiln is the simplest. The hot air is sucked off from the cooling chamber and introduced into the drying installation by means of pipes. Flue gases for heating drying installations can be used for direct heating only when rarefied with fresh air in order to prevent the discoloration of the ware by the chemical action of the gases. Airing the drying installation is important and is done by ventilators and exhausters. The ventilators remove the air saturated with moisture and prevent its being deposited on the drying ware. Ventilators which forward the greatest possible quantity of air with the least velocity are recommended. See also *Ceram. Abs.*, **9** [8], 684 (1930). M.V.K.

Drying installations with a continuous current. W. MAYBAUM. *Tonind.-Ztg.*, **55** [3], 38 (1931); for abstract see *Ceram. Abs.*, **9** [7], 551 (1930). M.V.K.

Twelve-hour drying system. F. RAULS. *Baublatt*, **37,** No. 18 (1930).—A patented system is described in which the most sensitive clays can be dried and hardened in one or more 12-hour periods. Provision is made for humidity drying and low-pressure drying with direct or alternating heating current. See also *Ceram. Abs.*, **10** [1], 57 (1931). (*Trans. Ceram. Soc.* [Eng.])

New rotary drier. STRUTHERS-WELLS CO. *Brick Clay Rec.*, **78** [1], 47 (1931).—

A new line of Timken-equipped rotary driers and kilns is announced which includes all sizes from 2 ft. 6 in. diameter to 10 ft. diameter and lengths from 20 to 200 ft. or more, suitable for the drying and calcining of granular in bulk. Illustrated. E.J.V.

Mangle drier in the platemaking shop. G. HELM. *Ber. deut. keram. Ges.*, **11** [8], 443 (1930).—A more adequate drier is described in this paper; one that overcomes the troubles arising from different drying times for the ware, according to the weather conditions, and one that also saves time for the molder. H. has tested the time work material-saving capacity of such a drier. The committee for machinery equipment of the German Ceramic Society sponsored these "time studies." Results are given together with data about capacity of such driers, costs, etc. Several driers have been installed with excellent results. I.R.

Casting ceramic bodies and different interesting applications of this method of fabrication. MARC LARCHEVÊQUE. *Céramique*, **32** [493], 61–67 (1930).—**IV.** Casting large hollow pieces with the aid of compressed air or vacuum. The casting of large hollow pieces requires internal pressure not only to obtain the necessary wall thickness but also to support the wall when the molds are dumped and during the initial stages of drying. Internal pressure is obtained by the action of compressed air inside the mold or of a vacuum outside the mold. Compressed air has been used at Sèvres since 1850 but the use of vacuum is more recent. L. describes the department at Sèvres which makes large pieces. With compressed air one must work empirically, but with vacuum the mold may be open and the process controlled by inspection. L. refers to work by B. J. Allen published in Céramique et Verrerie, Paris, January, 1928, in which, by means of vacuum, pieces were cast, set, and even dried in the molds. Diagrams from Allen's paper are reproduced. Compressed air must be used for very thick pieces. L. describes the casting of a large condenser giving a diagram of the mold. **V.** Multiple molds. Multiple molds are used for solid casting of such articles as plates, cup handles, etc. L. describes several types and the methods employed in making the molds. **VI.** Miscellaneous applications of the casting process. By the use of pigmented slips it is possible to cast vases which are white inside and colored outside or vice versa. Pieces like Wedgwood can be obtained by variations of this method. The making of engobe sanitary ware by "double casting" is also possible. With vacuum, it can be done in one operation. The casting of glass pots having a very resistant inner layer is mentioned. L. describes the difficulties caused by workmen adding water to the slip to make it more fluid. For Parts I, II, and III, see *Ceram. Abs.*, 9 [10], 857 (1930). A.E.R.W.

Electrodeposition of chromium-iron alloy. G. FUSEYA AND K. SASAKI. *Chem. News*, **141** [3689], 407–11 (1930).—Experiments were performed to find the best conditions of electroplating with so-called stainless iron, *i.e.*, iron containing more than 16% chromium. A solution of ferrous sulphate and chromium sulphate was used. The effects of (1) duration of electrolysis, (2) current density, (3) acidity, (4) temperature, and (5) concentration of ferrous sulphate were determined. G.R.S.

Alloys stable on heating. G. PRECHTEL. *Keramos*, **9** [25–26], 943–44 (1930).—P. discusses the advantages of objects made of alloys stable on heating over those made of cast or wrought iron, to be used for fusing pans and muffle constructions. M.V.K.

Soil sampling with a compressed air unit. H. F. BLANEY AND C. A. TAYLOR. *Soil Sci.*, **31** [1], 1–3 (1931).—The apparatus consists of a compressor unit mounted on a truck, a light hammer, and 100-foot length of hose. A complete description illustrated with photographs, is given of the equipment. A jack is used for pulling the soil tubes. G.R.S.

Clay mining. BUCHS. *Tonind.-Ztg.*, **55** [1], 7 (1931).—B. describes the ways of mining clay in different formations of clay deposits in Germany. M.V.K.

Mine transportation of limestone. RALPH W. SMITH. *Pit & Quarry*, **20** [8], 56–58 (1930); for abstract see *Ceram. Abs.*, 9 [8], 659 (1930). E.P.R.

Oil-hardening and air-hardening of cast iron. J. E. HURST. *Foundry Trade Jour.*, **43** [746], 385–87 (1930).—The properties of alloy cast irons of the nickel-chromium type after hardening and tempering are studied. The object of the experiments was to ascertain whether or not the strength properties of cast irons were impaired by the heat treatment. The preparation and treatment of the specimens are given. Methods of testing are described. Experimental results are given graphically and in table form. Tempering lowers the hardness value. The higher the temperature the lower the hardness value. The tensile strength values are seriously diminished by hardening but tempering causes a recovery of tensile strength values. The stress/deflection curves are influenced to some extent. The modulus of elasticity is decreased by hardening but recovers on tempering. Nickel-chromium cast irons cast by the centrifugal process can be hardened and tempered to develop higher ranges of Brinell hardness accompanied by a sorbitic structure. Photomicrographs are given. H.W.A.

Heat- and corrosion-resisting cast iron. ANON. *Nickel Bull.; Foundry Trade Jour.*, **43** [747], 403 (1930).—The alloy contains about 75% ordinary cast iron, 4% chromium, and 21% Monel metal and is known as "Nimol." Nimol is stronger and tougher than cast iron, withstands temperatures up to 600°C, and does not suffer growth at higher temperatures. The physical properties are listed. Nimol is used as superheater tube supports, as supports for firing enamelware, and other places where heat is encountered. In enameling furnaces at 850°C Nimol lasts 6 to 7 months compared to 7 to 10 days for ordinary cast iron. Nimol is more resistant to sulphuric acid than cast iron but is not resistant to nitric acid. Nimol resists atmospheric corrosion. Nimol is also nonmagnetic, a property which may be utilized in the future. H.W.A.

Fluid metering in practice. ED. S. SMITH. *Mech. Eng.*, **52** [11], 968–70 (1930).—This paper is offered as a basis for the Revision of Part I of the A.S.M.E. Fluid Meter Report and comments, suggestions, or criticisms are invited. The hydraulic equation is given and fully explained. In ordinary English units it is $Qu = (457.2)C \cdot Y \cdot a \cdot \sqrt{hW_1}$. Four figures or sets of curves are given which are valuable in making computations and estimates. The following terms are defined: Venturi tube, Venturi nozzle, Venturi nozzle-tube, flow nozzle, square-edged orifice with flange connections, square-edged orifice with throat connections, and square-edged orifice with pipe connections. H.W.A.

Application of chromium plating to the ceramic industry. H. C. WOLFE. *Ceram. Age*, **16** [6], 315–17 (1930); for abstract see *Ceram. Abs.*, **10** [2], 132 (1931). A.E.R.W.

Increasing the life of dies with chromium. E. SMITH. *Ceram. Age*, **16** [5], 270–72 (1930).—Chromium has several characteristics which make it effective in increasing the life and efficiency of dies. A.E.R.W.

Developments in machinery and plant. ANON. *Brit. Clayworker*, **39** [464], 324–25 (1930).—Automatic clay feeding, accelerated weathering by fine crushing, driers for raw clay, and fine grinding render limestone and some other materials harmless. The semidry process eliminates the use of a drier. Edge runners for mixing clays, auger-machines, automatic cutting tables, conveyers, driers, tunnel kilns, and automatic temperature control are discussed. R.A.H.

Wheel for making pottery. HAROLD L. MCCONAUGHY. *Popular Sci.*, **118** [3], 116 (1931).—Detailed directions are given for making a potter's wheel. Illustrated. E.J.V.

Electrolytic corrosion of underground cable. S. NUMATA. *Engineering*, **128**, 823 (1929).—Covering the pipes or duct in which the cables are laid with asphalt concrete is more successful than any other form of surface insulation. H.H.S.

Economy in the plant. W. F. SCHAPHORST. *Brick Clay Rec.*, **78** [2], 73 (1931).—Examples of false economy often practiced in the purchase of maintenance necessities such as belting, lubricants, etc., after careful economical purchase of machinery are cited. E.J.V.

BOOKS

Heating and Ventilating Degree-Day Handbook. HEATING AND VENTILATING, New York, N. Y. 56 pp. 3 folding charts and 22 maps. Price, $1.50. Reviewed in *Gas Age-Rec.*, **67** [2], 60 (1931).—The outstanding feature of this handbook is a series of tables representing more than 14,000 separate calculations, which give standard degree-days by months for 1000 American cities. A chapter is devoted to definition of degree-day, why the base 65° is used, how much fuel is required per square foot of radiation, and how to correct these figures for other conditions. E.J.V.

Knowledge of Grinding Material. (Zur Kentnis des Mahlgutes). A. H. M. ANDREASEN. Theodor Steinkopff, Berlin and Leipzig. 100 pp. Reviewed in *Feuerfest*, **5** [6], 108 (1930); for abstract see *Ceram. Abs.*, **8** [4], 301 (1929). M.V.K.

Measurement of a Rapidly Fluctuating Flow of Gas. J. G. KING AND B. H. WILLIAMS. Reviewed in *Colliery Guard.*, **141** [3643], 1525 (1930); for abstract see *Ceram. Abs.*, **10** [2], 135 (1931). E.J.V.

PATENTS

Filter cloth. CORNELIS HENRI CAALS. U. S. 1,788,657, Jan. 13, 1931. A filter cloth adapted to be used between the frames of filter presses consisting of two central woven filtering portions and a circumambient strengthened woven marginal portion in the shape of a rectilinear figure 8, the central filtering portions being within the marginal portions and being separated by the intermediate transverse portion of the figure 8.

Spraying booth, etc. JENS A. PAASCHE. U. S. 1,788,956, Jan. 13, 1930. In a self-contained ventilating unit, the combination of a fan housing having an inlet connection and a delivery-flue connection reaching sidewise from one side of the fan housing and at right angles to the inlet connection, a motor housing reaching sidewise from the side of the fan housing opposite to the flue connection, a motor within the motor housing, a shaft reaching across the fan housing from the motor to a position in the flue connection and an induced draft fan on the shaft located in the flue connection and operative effectively to draw air from the inlet connection and deliver the same into the flue connection, substantially as described.

Power press. DAVID CROSSLEY. U. S. 1,790,041, Jan. 27, 1931. A die consisting of a movable and a stationary member in combination with a frame connected to the movable member and carrying a follower, and means for adjusting the limit of motion of the follower.

Tile-making process. DAVIS A. CABLE. U. S. 1,791,234, Feb. 3, 1931. The method of making tile, etc., which includes forming a block of moist material, drying the block to beyond the plastic limit, truing the block, and then firing the block.

Glazing or coloring pottery. G. WADE & SON, LTD., AND G. A. WADE. Brit. 339,395, Jan. 28, 1931. A device for dipping pottery or earthenware into glazing or coloring liquid comprises a table or platform which can be lowered to a predetermined level in a tank containing the glaze, and a device for keeping the surface of the glaze at a constant level.

Kilns, Furnaces, Fuels, and Combustion

Kilns and kiln firing. Notes on the firing of fire brick in the Shaw chamber kiln VII. S. R. HIND. *Trans. Ceram. Soc.* [Eng.], **28** [2], 389–97 (1929); *Sprechsaal*, **63** [22], 411 (1930).—Investigations on the Shaw kiln were mainly centered around the firing of glazed brick and fireclay sanitary ware. Information is given by a firm using

a recently erected Shaw kiln for fire brick. Figures show a substantial economy in fuel over intermittent kiln practice. The Shaw kiln is a continuous gas-fired chamber kiln which has proved successful in the firing of most types of ceramic goods. The firing is under excellent control. Conditions of reducing, oxidizing, or substantially neutral atmosphere can usually be obtained and maintained as required. Pyrometric trials show a considerable variation in firing in various parts of the chamber, but the fired goods were satisfactory and it is not necessary to maintain a great uniformity. This could be done, however, if the nature of the ware called for it, but would require more time and fuel. A firing chart is given and shows a satisfactory record of firing up to the finish. Gas producers are used on a high-grade fuel and are maintained in excellent condition. Two ways in which the kiln dispenses with the heat supplied to it are the flue gases and the conduction of heat through the kiln walls, etc. For previous abstracts see *Ceram. Abs.*, **9** [4], 301 (1930). R.F.S.

Tunnel kilns vs. downdraft kilns. A. F. GREAVES-WALKER. *Ceram. Age*, **16** [3], 162 (1930).—G.-W. discusses briefly the advantages and disadvantages of railroad tunnel kilns and periodic downdraft kilns. The initial investment in the former is from $20,000 to $50,000 more than in the latter. If direct coal-fired kilns could be used the saving on fuel in the tunnel kilns would be about 50%, but this is impossible. Where oil and gas are used in the periodics, a great saving could be made by installing tunnel kilns. Tunnel kilns give much more uniform reds and buffs. Where uniform flashed blacks, red-browns, purples, greens, etc., are required the periodic kiln still has an advantage. A.E.R.W.

Preheating air for downdraft kilns. ANON. *Brit. Clayworker*, **39** [465], 378–79 (1931).—Downdraft kilns make a very inefficient use of the fuel burned in them for three reasons: (1) they waste a large amount of time and fuel in "drying off" the freshly-set goods; (2) being supplied with cold air, combustion of the fuel is either incomplete or much fuel is wasted in heating the air entering the kiln, and (3) the hot gases leave the kiln at a temperature of about 1000°C and the heat in them is wholly lost if not conducted to a drier or to an air heater and the heated air supplied to the kilns. A good type of air heater will recover as much as two-thirds of the heat discharged from the kilns. With an ample supply of hot air, it is not difficult to halve the ordinary fuel consumption and to increase the rate of firing. R.A.H.

Technical observations on the tunnel kilns in the ceramic industry. ALBERT HIRT. *Céramique*, **33** [509], 179–91 (1930).—After describing nine tunnel kilns which had been installed for firing refractories, sanitary ware, etc., H. makes a comparison of various firing methods giving the following table for their efficiencies.

Nature of Hearth or Gasifier	Efficiency %
Ordinary Siemens producer	65–70
Siemens producer with automatic cleaning	76–82
Automatic producer for hot gas	85–90
Automatic producer for cleaned gas	70–75
Direct firing without stokers	90–92
Direct firing with stokers	92–95

Very low-temperature gradients are reported for kilns fired with gas. The apparatus used for automatic temperature regulation is described. H. points out that the intermittent firing of fire boxes gives a fluctuating firing curve and causes an important loss of time. A discussion of firing curves for tunnel kilns is given and the factors governing temperature differentials are described. H. points out that lower differentials are found in the firing zone than at entrance or exit and explains this phenomenon on the

basis of stratification of gases. Methods for controlling the kiln atmosphere are described. Several successful recuperator installations are mentioned. H. also points out the advantages of maintaining a slight pressure in the cooling zone. A complete heat balance for a tunnel kiln is given and illustrated by a diagram showing the flow of heat in the kiln. A similar diagram is used in showing the flow of the gas in the kiln. A number of occurrences in connection with the installation of tunnel kilns are described which illustrate the necessity of thoroughly-dried unfired ware, and of having the softening point of the ware higher than that of the glaze. In one case, in which the same kiln was used alternately for bisque and glost, a number of cars of refractory ware were run through while the temperature of the kiln was changing. Means for avoiding accidents are discussed. A.E.R.W.

Vertical kilns for calcining clay and silica. ALBERT HIRT. *Céramique*, **33** [512], 272–80 (1930).—H. stresses the growing importance of the calcining operation in ceramics and the advantages of a vertical kiln fired with producer gas. *E.g.*, H. describes a battery of six vertical kilns used for calcining flint pebbles, each kiln having a production of 12 T. per day and using a weight of fuel which was 6 to 7% of the weight of flint calcined. The flue gases leave the kiln at 65°C and the pebbles at about 60°C so that the kiln is very efficient. The calcined pebbles fall on a rubber belt and do not burn it. H. also describes an installation for calcining clay for grog. In order to prevent plugging of the kiln by wet clay, about 80% of the flue gases from the calcining zone are mixed with air and passed down through the top of the charge to dry the clay rapidly. Schematic diagrams showing the heat quantities and gas volumes for the kilns are given. They are used in showing the advantages of the "predrying" scheme. Plans for a 100 T. per day plant are described. A.E.R.W.

Setting brick and tile in a continuous kiln. ANON. *Brit. Clayworker*, **39** [464], 329–30 (1930).—The manner of setting brick and tile in a continuous kiln has a marked effect on their quality. The chief factors in the setting are (1) distance of the headers from each other, (2) proportion of headers to stretchers in the cross-section of the kiln, (3) the amount of free space between the brick in "narrow" parts of the kiln should be equal to that in normal parts of the kiln, and (4) a slow fire-travel is due either to too close or too open a setting. The weaker the draft the more will the heat rise to the top of the chamber where the draft is greatest. R.A.H.

Observations on kilns examined during 1929 by the technical service of the French Society of Ceramic Manufacturers. V. BODIN AND P. GAILLARD. *Céramique*, **33** [508], 151–56 (1930).—Extensive tables are presented giving dimensions, setting, fuel consumption, and other operating data for 25 continuous kilns, 12 with automatic firing and natural draft, 5 with hand firing and natural draft, and 8 with automatic stoking and forced draft. Similar tables are presented for 6 periodic porcelain kilns. Curves showing the variation in temperature and atmosphere on firing two of the porcelain kilns are given as well as diagrams showing the distribution in temperature in the kilns when fired off. Comparison with similar reports for the six previous years showed that considerable savings in fuel consumption have been made. The data are discussed in detail and explanations offered for the difference in fuel consumptions. The measurements of temperature distributions in the kiln chambers showed very important variations but similar variations in the products were not found, from which it was concluded that firing temperature was not a critical factor. It was shown, however, that better temperature distribution would enable firing schedules to be shortened. The nature of the temperature distribution varies greatly from kiln to kiln.

A.E.R.W.

Dressler "carboradiant" kiln. ANON. *Ceram. Ind.*, **15** [2], 198 (1930); for abstract see *Ceram. Abs.*, **9** [8], 663 (1930). W.W.M.

Muffle kilns for Dutch tile. JOSEPH PÖLLMANN. *Sprechsaal*, **64** [1], 4–7; [2], 23–27 (1931).—P. describes the construction of several types of muffle kilns for the production of Dutch tile. M.V.K.

Blast kiln fired to 2600°. REINHARD JUNG. *Feuerfest*, **5** [6], 109(1930); for abstract see *Ceram. Abs.*, **9** [3], 225 (1930). M.V.K.

Insulation for high temperatures. E. F. ZEINER. *Power*, **73** [3], 104–106 (1931).—Important factors for suitable high-temperature insulating materials are (1) insulating efficiency, (2) mechanical strength to withstand shipping, handling, and application, (3) low heat shrinkage, (4) resistance to decomposing effect of high temperatures to insure reasonable life, (5) resistance to the effects of moisture, and (6) weight. Felted asbestos blocks are good insulating material at high temperatures. Other main classes of insulation are (1) high-temperature insulation in which diatomaceous earth is the base, and (2) high-temperature insulation in which no diatomaceous earth is incorporated. In the high-temperature range, radiation plays a large part in the transmission of heat. Thickness of wall, therefore, plays an important part. Structural strength of high-temperature materials is important. Transverse strength, impact resistance, and permanent lineal heat-shrinkage tests at high temperatures are desirable. The materials considered above are used up to 1400°F. Furnaces for temperatures over 1400°, although lined with fire brick, need insulation for heat conservation, temperature control, and comfort to workmen. Mono-bauxite which has an alumina base is capable of standing temperatures up to 2000°F. It is made in large blocks. Insulating cements are intended for filling joints, cracks, and depressions. High-grade cements tend to shrink and crack upon drying due to the water added. The insulating value of the cement, *e.g.*, 85% magnesia cement, should be the same as the block. The cement should be made of the same material as the block on which it is used. Covering capacity is of utmost importance in analyzing the relative value and cost of different cements. Sticking properties, low shrinkage, easy workability, and finishing qualities are important factors. H.W.A.

Close or open setting. ANON. *Brit. Clayworker*, **39** [464], 329 (1930).—If the draft is perfectly constant, it would matter little whether a kiln setting were close or open, as apart from friction, the chimney would draw the same quantity of air and gases through the kiln. If a kiln is set more closely the draft will increase, the gases and air mix more readily, and there is a tendency to form sharp, intensely hot flame points leading to irregular heating. A more open setting has a smaller draft, the air and gases diffuse more slowly and uniform heating is more easily attained. In most kilns best results are obtained with rapid fire travel and low draft. A close setting produces cracks and if the setting is too close the heating will occur in the cross-flues and sole, the other ware is heated too slowly, and water vapor tends to remain in the brick too long. On the whole, a moderately open setting is preferable to a close one. R.A.H.

Testing and rating of fuel-fired industrial furnaces. III. W. C. BUELL, JR. *Fuels & Fur.*, **7** [2], 243–46 (1929).—B. presents a number of typical charts which may be used for recording test data. Data are presented on four typical tests. **Reduction of fuel values to standard conditions of temperature and pressure. V.** *Ibid.*, **7** [4], 559–62 (1929).—B. points out the necessity for the reduction of full values to standard conditions of temperature and pressure, particularly in the case of gaseous fuels. Methods of performing these corrections are given for solid, liquid, and gaseous fuels. In the case of gaseous fuels, corrections for humidity are also given. The calculations are performed by means of general equations along with tables and charts. A.E.R.W.

Electric heat for ceramic kilns. J. T. JANS. *Ceram. Age*, **16** [6], 326–30 (1930).—For ceramic firing operations below 2000°F, metallic-resistor elements of nickel chromium alloy in ribbon, wire, or cast form are used. Electric firing for quality ware has

the following advantages: (1) A clean, oxidizing heat is maintained at all times. (2) Simple automatic temperature control eliminates the more uncertain human element in firing and the necessity of an expert fireman. (3) Due to the small temperature gradient between the work and the heating elements, the maintenance costs are low. The small number of electric kilns for firing below glost heat in operation is due to the high cost of power and the conservatism of the ceramic industry. The low-temperature kilns are used for porcelain enameling, glass annealing and decorating, and dinnerware decorating. There are two types of heating elements used from 2000 to 2350°F. These are the carbon trench and the Globar. At present the carbon trench element seems to be limited to installations of considerable electrical rating. The Globars are very easily replaced without shutting down the kiln. Both types have been used most successfully in tile manufacture. The use of electric heat in modern kilns will often show a lower firing cost than a periodic kiln fired with coal or oil. The cost of power must still be reduced considerably before electric heat can compete successfully with cheap natural gas in modern, well-designed kilns. A.E.R.W.

Globar: nonmetallic resistance electric-heating elements. ANON. *Engineering*, **128**, 814–15 (1929).—Globar, made by the British Resistor Co., Halifax, in rods of various sizes, resembles Carborundum in appearance. The specific resistance can be varied; standard types operate between 2000 to 2750°F and special types to 3000°F. The application of Globar to an electric furnace and the method of mounting are illustrated in two diagrams. H.H.S.

Briqueting of coal without use of pitch. ANON. *Gas Jour.*, **193** [3531], 153 (1931).—H. Hardy's process of briqueting of fine coal is described. An outline is given of the plant required for the process. Methods outlined are (1) the product may be briqueted while hot in a special form of press after leaving the heater; (2) the product may be allowed to cool below 212°F after which it is treated with water in a pulverizing machine, reheated to 212°F, kneaded, and briqueted in an ordinary press; (3) the product may be allowed to cool completely, after which it is moistened, kneaded, and briqueted without being reheated. G.R.S.

Combustion tests with Illinois coal. O. P. KRATZ AND W. J. WOODRUFF. Univ. of Ill., Eng. Expt. Sta., *Bull.*, No. 213, pp. 1–58 (1930); *Brick Clay Rec.*, **78** [2], 74 (1931).—A boiler unit at the University Power Plant was used. Freshly mined "pea" coal was fired as received. Conclusions are as follows: (1) No particular outstanding difficulties were encountered with any of the coals. (2) The average overall efficiency was 65.6% with Southern Illinois coals and 62.9% with Northern Illinois coals. (3) Maximum attainable capacity increased as the ratio of volatile matter to fixed carbon decreased. (4) The maximum average combustion rate was 44.8 lb. of dry coal per sq. ft. of grate surface per hour. (5) Small draft differentials through the fuel beds were required. (6) To be used as an index of operating conditions in an actual plant, the required observed percentage of CO_2 in the flue gas should be based on a consideration of the carbon-hydrogen ratio in the coal used, and of the probable carbon loss to the ash-pit and stack, as well as the excess air desired. A.E.R.W.

Sampling and analysis of coal for export. ANON. *Gas Jour.*, **193** [3529], 44–45 (1931).—The paper includes sampling of small fuel up to 3 in., larger sizes, and run-of-mine. G.R.S.

Coking a banded bituminous coal. C. P. FINN. *Gas Jour.*, **192** [3528], 965–70 (1931).—The banded ingredients of British bituminous coal are vitrain, clarain, durain, and fusain. Quantities of each were used for large-scale coking tests. Chemical analyses of the isolated ingredients and the results of coking are given in tables. The different samples of clarain, which forms the largest percentage of the banded ingredients, may vary considerably in their coking properties, but yield a comparatively poor

coke that is much fissured and breaks easily. Vitrain is proportionately more valuable than clarain in coking slack. Durain appears to exert little effect when present in a coking slack. Fusain, although noncoking, is valuable when uniformly admixed with the remainder of the coking slack and when present to an extent not exceeding about 5%. The presence of dirt is deleterious to the quality of the coke obtained. G.R.S.

Firing clay products with natural gas. FRANK R. MAHURIN. *Brick Clay Rec.*, **78** [2], 76–82 (1931).—Advantages of natural gas firing are enumerated. The design and layout of distributing piping, the methods of supporting pipe, and the various fittings and burners necessary are discussed. Firing is described in detail and special points pertaining to gas firing only are pointed out. Illustrated. E.J.V.

Nature and properties of certain hydrocarbons in coal gas, and their effect on meter leathers. R. S. ANDREWS. *Gas Jour.*, **193** [3531], 158–59(1931).—Unsaturated hydrocarbons polymerize in the presence of oxygen to gums and resins, and deposit on the meter leathers and moving parts with detrimental results. These compounds owe their origin to imperfect cracking. G.R.S.

Development of submerged combustion. C. FEATHERSTONE HAMMOND. *Gas Jour.*, **189,** 500–501, 583–86; *Gas World*, **92,** 14–15 (1930); *Fuel Econ.*, **4,** 385–88 (1929); for abstract see *Ceram. Abs.*, **9** [7], 563 (1930). (*C.A.*)

Heats of combustion of methane and carbon monoxide. FREDERICK D. ROSSINI. Bur. Stand., *Jour. Research*, **6** [1], 37–49 (1931) RP260.—With the use of the calorimetric apparatus and procedure employed for determining the heat of formation of water, the heats of combustion of methane and carbon monoxide have been measured. Comparison with previous work is given. R.A.H.

BOOK

Electrothermal Methods, the Production of Electricity, and the Use of High Temperatures. (Elektrothermie, die elektrische Erzeugung und Technische Verwendung hoher Temperaturen.) Edited by M. PIRANI. Julius Springer, Berlin, 1930. 291 pp. 36M. *Z. phys. Chem.* [*A*], **150** [2], 171 (1930); *Elec. World*, **97** [5], 246 (1931); *Feuerfest*, **6** [11], 171 (1930).—The application of electrothermal methods and the technique of measuring high temperatures are discussed. The book also includes a description of the method of manufacture of many products among which are included silicon carbide, alumina, graphite and carbon, calcium carbide, and quartz glass. See also *Ceram. Abs.*, **9** [12], 1115 (1930). L.T.B.

PATENTS

Gravity-feed tunnel kiln. TAINE G. MCDOUGAL. U. S. 1,788,885, Jan. 13, 1931. An inclined heat-treating tunnel having its entrance end at a higher level than its discharge end, and a driven conveyer at the discharge end of the tunnel for receiving ware therefrom, the mass of the ware on the conveyer resisting sliding movement of the ware through the tunnel, and the rate of movement of the ware being determined by the speed at which the conveyer is driven.

Method of firing brick kiln. ARTHUR J. THERRIEN. U. S. 1,790,882, Feb. 3, 1931. A stack of unfired brick ten brick-lengths long piled edgewise mainly three on three in crossing layers having two transverse arches a brick-length in width separated by a pier four brick-lengths in thickness and having a half pier at each end, the pier being supported on five groups of pick-up brick piled two high and two wide in parallelism and the half piers being supported each on three similar groups of pick-up brick.

Electric furnaces. CARBORUNDUM CO. AND C. E. HAWKE. Brit. 338,131, Jan. 7, 1931. Carbide resistances are protected by a non-oxidizing gas or a surrounding body of granular carbon. The resistances may be of silicon or boron carbide. The carbon may be in the form of crushed petroleum coke.

Apparatus for thermal treatment of bituminous fuels. A. WEINDEL AND H. NIGGEMANN. Ger. 491,871; *Gas Age-Rec.*, **67** [5], 187 (1931).—The chamber oven is heated on one side only. The feature of the apparatus is the use of longitudinal ribs located at one or several places in the unheated walls, on the sides opposite the charge, and within the chamber filled with bituminous coal. Vertical gas-collecting conduits are located within the unheated walls and are connected with the longitudinal ribs. These conduits are distributed at certain intervals along the entire length of the unheated walls. E.J.V.

High calorific power gas. O. MISCH. Ger. 494,016; *Gas Age-Rec.*, **67** [5], 187 (1931).—The apparatus is used for the production of a high calorific-power mixture of water and coal gas. Both the water-gas generator and the coal-gas retorts are kept separate. Connections between the two are provided. These consist of blow-gas and water-gas pipes with branch connections to the combustion chamber and the carbonization retorts. Suitable valves are provided in these connections. The branch connection which serves for the water gas is led through the combustion chamber for the purpose of heating the water gas before it enters the coal-gas retorts. See also *Ceram. Abs.*, **9** [9], 780 (1930). E.J.V.

Water-gas process. I. G. FARBENINDUSTRIE A.-G. Ger. 496,342; *Gas Age-Rec.*, **67** [5], 187 (1931).—Water-gas is produced in a film of finely-granulated fuel with vigorous circulation of the gasified mass. Fresh bituminous fuel is fed into the incandescent fuel layer while blasting. E.J.V.

Mixed gas manufacture. DESSAUER VERTIKAL OFEN G. M. B. H. Ger. 496,436; *Gas Age-Rec.*, **67** [5], 187 (1931).—This process involves the manufacture of mixed gas from coal gas and water-gas. It is carried out in an oven for the production of both gas and coke from low-value fuels. The chamber or retort, which is filled with several layers of coal and low-grade fuel lying on top of the coal, is heated externally. Arrangements are provided for blowing steam into each layer of coal after the layer of low-value fuel has been brought to red heat; this layer is located directly above the coal layer. E.J.V.

Carbonizing process. CHEMISCH-TECHNISCHE G. M. B. H. Ger. 497,714; *Gas Age-Rec.*, **67** [5], 187 (1931).—The carbonization of coal, lignite, etc., is carried out in stationary vertical chambers which are arranged radially around a central axis and separated by heating walls. The coal is fed from the central axis radially outward into the carbonizing chambers. E.J.V.

Continuous carbonizing retort. E. ROSER. Ger. 497,973; *Gas Age-Rec.*, **67** [5], 187 (1931).—The retort is a rotary drum made to rotate within a stationary cylinder. The space between the inner and outer cylinders is divided up into a number of annular chambers for holding the fuel. Both the inner and outer cylinders are heated; a masonry construction surrounds the cylinders, and fuel is fed into the inner rotary cylinder through a funnel-shaped device which extends through the masonry. E.J.V.

Gas producer with stationary grate. I. G. FARBENINDUSTRIE A.-G. Ger. 498,296; *Gas Age-Rec.*, **67** [5], 187 (1931).—Above this grate is located a rotary stirrer or poking arrangement for removal of the clinker. This form of producer is especially suited for the gasification of finely-ground fuels. The clinker is removed by the stirring device into an opening located in the middle of the grate. E.J.V.

Regulating gas pressure in chamber ovens. C. OTTO & CO. G. M. B. H. Ger. 498,832; *Gas Age-Rec.*, **67** [5], 187 (1931).—The process of regulating the gas pressure in the chamber oven is accomplished by the use of a throttling member which is located in the main, conducting gas away from the ovens. The gas-pressure curve for a definite kind of coal that is being carbonized in the chambers is first established and a special member is made in the shape of this curve and connected with the throttling device.

This is done in such a manner that the throttling device is automatically actuated and adjusted corresponding to the gas-pressure curve. E.J.V.

Geology

Laws of soil colloidal behavior. I. SANTE MATTSON. *Soil Sci.*, **28**, 179–220 (1929).—The anions, chloride and sulphate, are negatively adsorbed by soil colloids in neutral or alkaline solutions, *i.e.*, the concentrations of anions are greater in the liquid outside a colloid than in the solution within the gel after equilibrium is established. Negative adsorption is greatest in a Na-saturated colloid and least in a Ba-saturated one as shown by the series Na > K > Ca > Ba. Negative adsorption of anions from Na salts by bentonite shows the following order: $Cl = NO_3 < SO_4 < Fe(CN)_6$. Ions of the higher valences show the greater negative adsorptions. The PO_4 ion, however, is positively adsorbed under all conditions of p_H. In the absence of free electrolyte the electric charge, the swelling, and viscosity are governed by the degree of dissociation of the exchangeable cations. The greater the dissociation the greater the imbibition of H_2O, etc. The dissociation depends upon the specific nature of the cations as shown by such characteristics as hydration and potential, and not upon valence alone. In the presence of free electrolyte the electric charge, the swelling, and the viscosity are suppressed and this suppression depends solely upon the valence of the ions. The Donnan equilibrium is to be dealt with as an effect and not as a cause. It does not create the phenomena mentioned but is merely related to their suppression. All of these phenomena are effects of the same cause, *i.e.*, the formation of an ion atmosphere around the colloidal particles. **II. Cataphoresis, flocculation, and dispersion.** *Ibid.*, **28**, 373–409 (1929).—A suspension of bentonite requires, for complete flocculation, a concentration of 0.02 *N* NaCl, 0.03 *N* Na_2SO_4 and 0.04 *N* $Na_4Fe(CN)_6$. The cataphoretic potential is higher after flocculation than in the aqueous suspension. The potentials resulting from electrolyte treatments calculated from migration velocities in terms of millivolts are untreated suspension—58.2, 0.04 *N* NaCl—78.3, 0.04 *N* Na_2SO_4—83.1, 0.04 *N* $Na_4Fe(CN)_6$—84.5. The concentrations necessary to flocculate do not give constant critical potentials, but these increase with valence of the anion. Original Sharkey soil colloid requires several times the concentration of various electrolytes to produce flocculation that is required by the electrodialyzed product. There is no parallelism between cataphoretic potential and stability. The cataphoretic potential depends on the nature of the adsorbed cations while the suppression of the potential difference and stability are governed more by the free electrolyte. Because of the amphoteric behavior of soil colloids which contain a high proportion of sesquioxides, the influence of acids may be very different in different colloids depending upon their composition. The negative charge of a colloid of high silica/sesquioxide ratio is reduced in magnitude but the sign of the charge is not changed. The negative charge of a colloid in which this ratio is low may be reduced by a low concentration of acid; then as the strength of acid is increased such colloids become isoelectric and later positively charged. Ions of opposite sign always enter into an exchange reaction with the ions present in the complex. If the ingoing ion is more highly dissociated by the complex than the ion originally present, then the charge, the osmotic hydration, and the dispersion tend to increase; if less dissociated these values will all decrease, and the sensitivity to electrolytes will increase. Osmotic hydration of the micelles is sufficient to account for the stability of suspensions. (*C. A.*) **III. Isoelectric precipitates.** *Ibid.*, **30** [6], 459–94 (1930).—There are many isoelectric "phosphates" and "silicates." The more highly phosphated or silicated the complex the lower is the isoelectric p_H. The lower the phosphate or silicate concentrations in the solution the greater is the rela-

tive proportion entering into combination. In high concentrations of the phosphate and silicate ions the isoelectric complex approaches but never attains full saturation, *i.e.*, $P_2O_5/Al_2O_3 = 1$ and $SiO_2/Al_2O_3 = 3$, provided that other cations which form insoluble phosphates and silicates are absent, and that colloidal silica is not precipitated with the complex. All of the ions in the system mutually displace one another according to the energy of each. At the isoelectric point there is always a certain small number of diffusible anions in combination. At that point the anionic and cationic dissociation must be equal. There is a balance between cations and anions in the complex, but a stoichiometrical relationship between any two ions must be accidental and should not be looked for even when the colloid is "purified." This applies to the more or less crystalline natural colloids as well, for although the law of definite proportions must hold as far as the interior of the crystal is concerned, there is no such definiteness on the surface, which is very great in the colloids. The adsorption layer is very complex in its make-up and changes constantly with the conditions, such as the nature and concentrations of the ions in the solution, the p_H, and the temperature. The paper explains the occurrence of the highly silicated and base-saturated soil colloids in the arid regions, the moderately silicated and more or less base-unsaturated soil colloids in the temperate and colder humid regions, and the almost completely desilicated and base-unsaturated soil colloids in the humid tropical regions. G.R.S.

Structure of chrysotile $H_4Mg_3Si_2O_9$. B. E. WARREN AND W. L. BRAGG. *Z. Krist.*, **76** [3], 201–10 (1930).—Chrysotile is a member of the serpentine group. The unit cell is monoclinic, with $a = 14.66$ Å, $b = 18.5$ Å, $c = 5.33$ Å, and $\beta = 93°16'$. The space group is probably C_{2h}^3. The structure indicates a formula expressed by doubling the usual molecule and writing it $(OH)_8Mg_6Si_4O_{11}$, H_2O. There are four of these molecules in the unit cell. In the above formula, the hydrogen atoms have been associated with an oxygen atom which, in the structure, is found to have a definite position at symmetry centers. The nature of the structure indicates that there are no water molecules but that each hydrogen atom is shared by two oxygen atoms, O—H—O. Each silicon is surrounded by four oxygens tetrahedrally arranged. Part of the oxygens are shared between neighboring tetrahedra forming endless chains of silicon-oxygen tetrahedra lying parallel to the c axis. The chains have a composition Si_4O_{11} and are similar to the chains previously found in the amphiboles. Between the sets of chains are sections of Mg and OH arranged as in brucite. The lateral binding between the chains is weak, being largely due to secondary forces only, and the structure therefore offers a ready explanation of the fibrous nature of chrysotile, and of the fact that the fibers are so flexible and easily separated. A large part of the fibrous asbestos of commerce is chrysotile. G.R.S.

Beryllium in minerals and igneous rocks. H. S. WASHINGTON. *Amer. Mineralogist*, **16** [1], 37–41 (1931).—The recent discovery of beryllium in vesuvianite from Franklin, N. J., suggests a new source of supply for beryllium, and it also simplifies the chemical formula of vesuvianite. In silicate analysis BeO is precipitated with and weighed as Al_2O_3. Examples are given where an excess of Al_2O_3 in minerals cannot be accounted for. W. concludes that beryllium is more abundant and wider spread than formerly believed. The separation of BeO from Al_2O_3 is not difficult and should be made in analyzing silicate minerals and rocks. G.R.S.

Fluorine and fluorine compounds forming minerals. W. PUKALL. *Sprechsaal*, **63** [51], 969–70 (1930).—When a pure kaolin in a carefully elutriated state is heated to about 1000° with an excess of common salt, it changes into the compound $4SiO_2{\cdot}2Al_2O_3{\cdot}Na_2O$ by absorbing Na_2O. If potassium chloride is used, the corresponding potassium composition is formed. When aluminium chloride is used with alkali chloride, a fine flaky substance is formed at about 800 °C, $3SiO_2{\cdot}3Al_2O_3{\cdot}K_2O$ (or Na_2O). This substance

is easily decomposed by dilute HCl and, with the separation of alumina, alkalis, and silica, changes back into the clay substance. This substance can also be obtained by heating the clay substance to redness to about 700°. Kaolin is thus a separation product. With the substitution of aluminium chlorides by the fluoride of the metal, fluorine easily reacts with silicic acid and forms silicofluorides. Tables are given which show that fluorine compounds, with regard to their action as mineral builders, control not only some silicate groups but the whole field of silicates. In the same manner, the identical reaction can be used for the disintegration of minerals containing silica, as feldspar. The kaolinizing process can be traced back to the influence of a fluorine compound on feldspar or on natural rocks containing feldspar. P. describes researches made on the disintegration and formation of feldspar and kaolin produced directly from elements. M.V.K.

Crystallographic classification. VICTOR GOLDSCHMIDT. *Amer. Mineralogist*, **16** [1], 18–33 (1931).—Definite relations exist between morphological and remaining properties of crystals, hence the importance of morphological classification. A critical discussion is given of (1) the six crystal systems which constitute the foundation of the morphological classification, and (2) the thirty-two symmetry classes. G. concludes that (1) is to be retained and (2) set aside. An attempt is made to trace historically the reason for many mineralogical teachers deciding in favor of (2). G.R.S.

Methods in crystal analysis. I. Fourier series and the interpretation of X-ray data. A. L. PATTERSON. *Z. Krist.*, **76** [3], 177–86 (1930).—A few of the problems of X-ray crystal analysis are stated in terms of Fourier analysis. The appropriate form for the Fourier series representing the scattering power is discussed and some of the properties of the one- and two-dimensional reduced series are given. The effect of structural "smearing out" on the X-ray diffraction picture is discussed briefly. **II. Enhancement principle and the Fourier series of certain types of function.** *Ibid.*, 187–200 (1930).—Two methods of approach are (1) solution of an equation of the second degree when only limited information as to the coefficients is given, and (2) trial and error, in which certain distributions are assumed and their analyses carried out. This leads to results agreeing with those obtained by the first method. G.R.S.

Crystal structure of muscovite $KAl_2(AlSi_3)O_{10}(OH)_2$. W. W. JACKSON AND J. WEST. *Z. Krist.*, **76** [3], 211–27 (1930).—The structure of muscovite has been examined by both quantitative and qualitative methods. The structure found confirms that proposed recently in outline by Pauling (see *Ceram. Abs.*, **9** [11], 972 (1930)) and discusses the close connection which exists between the pyroxenes and amphiboles on the one hand and the mica-like structures on the other. G.R.S.

Base-exchange materials used in water-softening. A. R. MARTIN. *Chem. & Ind.*, **49**, 197 (1930).—Comparisons were made on natural and synthetic base-exchange materials, the former being borromite, kenselite, refinite, natrolith, and the latter doucil and basex. Tables of results are given. In natural materials the action takes place only at the surface; in synthetic, there is an interior action which results in quicker softening. See also *Ceram. Abs.*, **10** [1], 77 (1931). H.H.S.

Determination of chromium in ruby. W. J. O'LEARY AND JACOB PAPISH. *Amer. Mineralogist*, **16** [1], 34–36 (1931).—The chromium content of naturally occurring ruby has been determined by a standard analytical method and is found to amount to 0.10% and 0.25% Cr_2O_3. G.R.S.

Rarer constituents of clays. A. FIOLETOV. *Chem. Zentr.*, ii, 3246 (1929); for abstract see *Ceram. Abs.*, **9** [11], 979 (1930). (*B.C.A.*)

Calcination or enrichment of phosphate rock. C. G. MEMMINGER, W. H. WAGGAMAN, AND W. T. WHITNEY. *Ind. Eng. Chem.*, **22** [5], 443–46 (1930); *Rock Prod.*, **33** [14], 74–76 (1930).—The calcination of phosphate rock was developed because of the

scarcity of the high-grade natural product. Two full-sized calcining units with a daily capacity of 600 tons have been operated more or less continuously for 12 yrs. Photographs and diagrammatic sketches of the installation are included as is a table showing the analysis of pebble phosphate before and after calcining. R.G.M.

Boehmite of bauxites. RAYMOND HOCART AND JACQUES DE LAPPARENT. *Compt. rend.*, **189**, 995–96 (1929); for abstract see *Ceram. Abs.*, **9** [8], 671 (1930). (*C.A.*)

Cellular honeycomb structure in rock-weathering. JACQUES BOURCART. *Geog. Jour.*, **76**, 444–45 (1930).—Corsica has a landscape dominated by taffoni, or rocks of alveolar erosion. The most striking are in granites. In limestones, tubes rather than niches are found. Two factors are necessary: permeability and an abundance of salts, especially chlorides, in the penetrating waters. H.H.S.

Sources of potash in the U.S. T. R. OLIVE. *Chem. Met. Eng.*, **37** [12], 728–31 (1930).—In the U.S. there are four potash sources, natural brines, sylvinite, wyomingite, and polyhalite, the last three yet unexplored, which may become serious competitors in a market now dominated by foreign production. Polyhalite ($2CaSO_4 \cdot MgSO_4 \cdot K_2SO_4 \cdot 2H_2O$) was found by the Bureau of Mines in commercial quantities in Texas and New Mexico. Laboratory work on polyhalite resulted in the development of two processes, one yielding $K_2SO_4 \cdot MgSO_4$, the other only K_2SO_4. The cost of production was less than $16 per ton of K_2SO_4 (90%) and slightly under $8 per ton of the double salt (48% K_2SO_4). A brief description of the process is given. Research on sylvinite, a eutectic mixture of KCl and NaCl, indicates that the production of potash salts from this mineral can be accomplished more cheaply than by any process yet developed for polyhalite. From wyomingite (containing 11.5% K_2O) the potash is extracted by means of a concentrated soda brine. Several other processes which have been tried and suggested are outlined. It is not unlikely that another decade will find the U.S. in a position of imminent, if not actual, potash independence. G.R.S.

"Andalusite," a ceramic product. W. M. MYERS. *Corriere ceram.*, **10**, 351–55 (1929).—The properties of natural and artificial sillimanite and the transformation of andalusite and cyanite into sillimanite (now done on commercial scale) are discussed. The andalusite output from a large deposit in Mono County, Calif., amounts at present to 70 tons per week. The porcelain obtained by substituting part of the feldspar by beryl cannot be manufactured commercially on account of the scarceness of beryl. The manufacture and properties of synthetic spinel are described briefly. (*C.A.*)

Value of aerial photography in soil surveys and classification. J. A. PRESCOTT AND J. K. TAYLOR. *Jour. Coun. Sci. Ind. Research* [Australia], **3**, 229–30 (1930).—Four photographic plates illustrate the use of aerial survey in choosing bore holes for soil examination. H.H.S.

Domestic clay mined and sold in 1929. ANON. *Clay-Worker*, **95** [1], 23 (1931); for abstract see in *Ceram. Abs.*, **10** [2], 155 (1931). E.J.V.

German soda ash and caustic soda trade. WILLIAM T. DAUGHERTY. *Commerce Repts.*, **52**, 790–91 (1930).—It is estimated that German production of soda ash fell to around 600,000 metric tons in 1929, against 800,000 tons in 1928. Caustic soda held its own, with a production of around 110,000 to 120,000 tons, comparable with the peak 1928 output. E.J.V.

Russian manganese ore. ANON. *Engineering*, **128**, 826 (1929).—Since 1928 the Russian Manganese Export Co. has had the exclusive right of exporting Mn ore from Chiatura, Georgia, and Nikopol, Ukraine. The output during the 9 months ending June, 1929, was 897,389 T. from Chiatura and 853,800 T. from Nikopol. The U.S. is the principal importer, taking 150,961 T. in the first 7 months of 1929; Holland came next with 69,153 T. H.H.S.

BOOKS AND BULLETINS

Tables for the Determination of Minerals by Means of Their Physical Properties. 2nd ed. EDWARD H. KRAUS AND WALTER F. HUNT. 261 pp. McGraw-Hill Book Co., New York. $3.00. Reviewed in *Amer. Mineralogist*, **16** [1], 42 (1931); *Mining & Met.*, **12** [290], 18 (1930).—The tables contain 250 mineral species, which number is large enough to include all the important ore and rock-forming minerals and yet not enough to over-load the tables, thus complicating their use and confusing the individual. The arrangement is well thought out and practical. The descriptions are concise and to the point. Color, the most variant of the physical properties of nonmetallic minerals, has been carefully considered, and the variations, even when rare, are put in their proper places. Particularly useful are the remarks under characteristics and associates. Also there has been added a table arranged according to their specific gravity, including the chemical formula of each species. G.R.S.

Formation of the Mediterranean Red Earths. (Terra Rossa.) (German.) A. REIFENBERG. With preface by A. Fodor. Pp. iv + 93. T. Steinkopf, Dresden, and Leipzig, 1929. Price 5 Rm. Reviewed in *Chem. & Ind.*, **49**, 188 (1930).—The red earths colloidally studied by R. in Palestine arise as a consequence of the protective action of silicic acid upon the otherwise sensitive sols of Fe and Al hydroxides. H.H.S.

Agglomeration and leaching of slime, etc. J. D. SULLIVAN AND A. P. TOWNE. Bur. Mines, *Bull.*, No. 329, 60 pp. Price 15¢. This report presents experimental data to show what may be expected when leaching on a large scale under conditions approximating those in practice. R.A.H.

Potash bibliography to 1928 (annotated). J. F. T. BERLINER. Bur. Mines, *Bull.*, No. 327. 578 pp. Price 90¢. The bulletin is a review and compilation of technical literature on potash salts (including the alunites) and their foreign occurrence. R.A.H.

Diatomaceous Earth. ROBERT CALVERT. Reviewed in *Gas Age-Rec.*, **67** [4], 118 (1931); *Rock Prod.*, **34** [1], 152 (1931); see also *Ceram. Abs.*, **10** [3], 222 (1931). E.J.V.

Chemistry and Physics

Plasticity. FELIX SINGER. *Feuerfest*, **5** [6], 101–102 (1930).—Plasticity is produced by the colloidal state of the clay and by some of its physical properties, mainly its lamellar form and adsorption and absorption processes. It presents both solid and liquid phases simultaneously. The solid phase consists of lamella of 0.5 to 9 micromillimeter of the so-called clay substance and smaller particles in slight but varying quantities which are of great influence. The clay substance is subject to certain adsorption processes. An active surface layer surrounded by a water film is formed on the lamella-shaped particles. The colloidal particles present react differently from the clay substance: the liquid phase exerts on them a more peptizing action. These particles absorb the liquid, swell, and reinforce the moving binding layer between the clay particles. When the clay is moistened by acid, the colloidal constituents are flaked and cover the noncolloidal, granulated, and undissolved particles. The newly-formed jelly-like layers begin to swell simultaneously by absorbing water. Acids greatly promote the swelling capacity of the gel. With additions of alkalis, the colloidal clay particles are brought into a colloidal solution, and the mass is liquefied. The more finely ground are the constituents of the mass, the greater the adsorption phenomena. The degree of plasticity is determined by the extent of the filling of the hollow spaces by the liquid. As soon as all capillaries are filled with water, the maximum plasticity is reached. M.V.K.

Electrical dewatering of clay suspensions. CARL E. CURTIS. *Jour. Amer. Ceram. Soc.*, **14** [3], 219–63 (1931).—The history of the developments by Count Schwerin, application at Carlsbad with detailed description of the plant, and review of the investigations of others on dewatering of clays by electrophoresis are given at length. The investigations by C., including a description of the apparatus, materials, voltage, and electrolytes are described with a statement of the results obtained with variations of each factor. The possible efficiency as a clay dewatering means is discussed. Plasticity theories are discussed in the light of the evidence obtained. The power cost is from 65 to 80 cents per ton of clay. On the average, clay dewatering by electrophoresis is no more efficient than the filter press, but it has shown greater efficiency on very fine-grained clays. Bibliographies are appended on (1) colloids in clays, (2) theories applying to electroendosmosis, (3) electromosis, and (4) Schwerin's patents. A short biographical sketch of Count Schwerin is also appended.

Electrical dewatering of clay suspensions. ANON. *Ceram. Ind.*, **15** [3], 304 (1930); *Ceram. Age*, **16** [3], 165–66 (1930); *Pit & Quarry*, **20** [13], 57 (1930); for abstract see *Ceram. Abs.*, **9** [4], 297 (1930); for abstract on complete article see previous abstract.

Effects of electrolytes on the dispersion of a clay suspension. F. ALLAM. *Chem. Erde*, **5**, 276 (1930); *Bldg. Sci. Abs.*, **3**, 238 (1930). (*Trans. Ceram. Soc.* [Eng.])

Some chemical reactions of colloidal clay. RICHARD BRADFIELD. *Jour. Phys. Chem.*, **35** [1], 360–73 (1931).—Colloidal clay is that fraction of the clay having an effective diameter of less than 100 millimicrons. This fraction is much larger than earlier workers believed, 20 to 50% being common, some clays containing as high as 80 to 90%. A large portion of particles of most clays are plate-like in form. The SiO_2/R_2O_3 ratio in the clays of the corn-belt region is about 3 to 1 while nearer the tropics the R_2O_3 increases and in extreme cases SiO_2 disappears altogether. Cation exchange reactions are associated largely with the colloidal fraction, varying from 0.30 to 1.00 milli-equivalent per gram. The extent to which a replacement of basic by hydrogen ions has proceeded is a measure of the degree of weathering of the clay. Some clays have 60% of exchangeable hydrogen. In electrodialysis a definite quantity of base can be removed and the resulting clay is saturated with H ions. Characteristics of hydrogen clays were determined. A group of curves obtained by titrating 100 cc. of 1% electrodialyzed clay sols with 0.1 *N* NaOH using the hydrogen electrode are shown. It is possible to calculate (1) the relationship between the p_H value of clay suspensions and the concentration of such suspensions, (2) the p_H values resulting when clay acids are treated with various increments of standard hydroxide solutions, and (3) the reactions resulting when clay acids of known combining weight are treated with the salts of acids of known pK value. $pK = p_H + \log \text{salt/acid}$. Viscosities of certain clay sols containing different amounts of bases are shown as a series of curves. G.R.S.

Clay and water. H. SALMANG. *Kolloid-Z.*, **48**, 377–80(1929).—A review is given covering the last 6 years. (*C.A.*)

Dry strength of clays. H. KOHL. *Ber. deut. keram. Ges.*, **11** [6], 325 (1930).—In literature, authorities advise drying clays at higher temperatures before testing transverse strength. It has been tested whether by a drying treatment important properties of the raw green clays are changed. The testing apparatus is described. The influence of different preparations and different additions on the transverse strength are tested. Specially good preparation and storing proved favorable. An addition of soda and of sodium silicate increased the dry strength. Sulphide lye does the same. A brick clay with probably a high colloid content and only medium plasticity proved to be a material of highest dry strength. Several clays were tested from the green state up to air-dried, and after heating from 30 to 250°. In the air-dried state (3 to 1% moisture) the data are constant but increase rapidly with temperature. Those

dried at high temperatures, if moistened again, will have a lower strength than before the heating. I.R.

Some fundamental definitions of rheology. E. C. BINGHAM. *Jour. Rheol.*, **1** [5], 507–16 (1930).—The need for greater accuracy of data of rheology is emphasized. Most of the troubles of the past have arisen from three sources, (1) lack of uniform standard substance for use in calibration, (2) a general disregard of simple but important corrections, and (3) tests are not ordinarily made to ascertain whether or not the instrument in use is functioning properly. Definitions are offered to stimulate discussion and to elicit criticisms. The following terms are defined: consistency, fluid, fluidity, viscid, solid, plasticity, yield value, mobility, stiffness, elasticity, rigidity, cohesion, adhesion, strength, shortness, hot shortness, cold shortness, toughness, tackiness, hardness, softness, pasty, glutinous, livery, greasy, lean, fat, slippery, lubricant, body, solubility, plasticizer, melting point, workability, thicken, inspissate, temper, cut, brittleness, ductility, malleability. See also *Ceram. Abs.*, **9** [4], 308 (1930). G.R.S.

Report on boron estimation. O. F. KRUMBOLTZ. *Jour. Assn. Official Agr. Chem.*, **13**, 422–23 (1930).—Recoveries of H_3BO_3 from soil varied from 95 to 97%. It is recommended that present methods, especially that of distilling B with super-heated steam, be more thoroughly studied. H.H.S.

Viscous flow and surface films. RONALD BULKLEY. Bur. Stand., *Jour. Research*, **6** [1], 89–112 (1931) RP 264.—This paper describes experiments which have been made on the flow of various liquids through fine glass and platinum capillaries in an attempt to detect any departure from the laws of simple viscous flow. The results are in agreement with the laws of simple viscous flow for all the liquids investigated. R.A.H.

Zirconium. VI. Use of dispersoids in the detection of traces of potassium by zirconium sulphate. R. D. REED AND J. R. WITHROW. *Jour. Amer. Chem. Soc.*, **52** [7], 2666–68 (1930); for Part V see *Ceram. Abs.*, **9** [7], 577 (1930). R.G.M.

Vapor pressure of antimony trioxide. W. B. HINCKE. *Jour. Amer. Chem. Soc.*, **52** [10], 3869–77 (1930).—H. reports the measurement of the vapor pressures of cubic and orthorhombic solid antimony trioxide between the temperatures of 470°C and 650°C by the gas saturation method. The vapor pressure of liquid antimony trioxide was determined over the temperature range from 656 to 800°C using a new type of static balanced tensimeter. These values were checked by direct tensimeter measurement. Heats of vaporization and transformation were calculated from the vapor pressure data and are included. R.G.M.

Heat capacities at low temperatures of antimony, antimony trioxide, antimony tetroxide, and antimony pentoxide. C. T. ANDERSON. *Jour. Amer. Chem. Soc.*, **52** [7], 2712–20 (1930); see also *Ceram. Abs.*, **10** [1], 70 (1931). R.G.M.

Minerals of synthetic fusions. K. KOYANAGI. *Jour. Soc. Chem. Ind.* [Japan], **33** [5], 161*B* (1930); *Tonind.-Ztg.*, **54** [68], 1123 (1930).—Fusions of the combinations $2CaO{\cdot}SiO_2$, $3CaO{\cdot}SiO_2$, and $8CaO{\cdot}2SiO_2{\cdot}Al_2O_3$ were prepared from the purest raw materials. Pieces of these fusions were observed under a polarization microscope and the separated minerals were compared with alite from a Portland cement clinker. In all fusions crystalline needles of a strong double refraction were found; these needles were the most abundant in the $2CaO{\cdot}SiO_2$ fusion and represent clearly bicalcium silicate. Only in the $3CaO{\cdot}SiO_2$ fusion were weak crystals of double refraction determined, which correspond to alite. In fusions in which great quantities of uncombined lime were determined by the glycerine method, K. continually observed rich formations of quite small round or elliptical granules which combined in groups or were found in dendritic order and probably consisted of uncombined lime. Nine microphotographs complete the article. M.V.K.

Oxidation and reduction of silicates of iron by gases. B. BOGITCH. *Compt. rend.*,

189, 581–83 (1929).—The oxidation of Fe silicates by mixtures of O_2 and N_2, and the reduction by mixtures of CO and CO_2 and by H_2 at 1300° were followed by means of determinations of FeO and total Fe. The colors depend on degree of oxidation, ranging from yellow through green to blue. One blue compound corresponds to a lower oxide than FeO. For previous abstract see *Ceram. Abs.*, **8** [6], 450 (1929). (*C.A.*)

A few new cobaltites of the spinel type. SVEN HOLGERSSON AND ALDO KARLSSON. *Z. anorg. allgem. Chem.*, **183,** 384–94 (1929).—These cobaltites have the general formula RCo_2O_4 and are prepared by evaporation and subsequent ignition of mixed nitrates. Thus $CuCo_2O_4$ is prepared from $Cu(NO_3)_2 \cdot 6H_2O$ and $Co(NO_3)_2 \cdot 6H_2O$, the final ignition being at 800 to 850° for a few hours. It is a black metallic substance with a density of 6.28, exhibits no ferromagnetic properties, and is not attacked by concentrated HCl, HNO_3, or NaOH. In preparing $MgCo_2O_4$ the final ignition must be carefully made over a Bunsen burner. It is a black powder (density 4.96), shows no ferromagnetic properties, but is soluble in concentrated HCl on heating to give a greenish blue solution. The mixed nitrates are ignited at 800 to 850° in preparing $ZnCo_2O_4$. The powder obtained (density 5.94) is insoluble in hot concentrated HCl or NaOH and is not ferromagnetic. In the case of the corresponding Mn compound part of the Mn has been replaced by Co and part of the Co by Mn, giving the following spinel formula (Mn, Co)O·(Mn, $Co)_2O_3$. The black powder is insoluble in cold concentrated HCl but on heating is soluble to a greenish blue solution. It is insoluble in NaOH and is not ferromagnetic. The corresponding Ni compound is strongly ferromagnetic, is insoluble in cold concentrated HCl and in NaOH but is soluble in hot concentrated HCl. As with the Mn compound, the Ni and Co are to a certain extent mutually replaceable. A Röntgenographic study of these compounds, as well as Co_3O_4, shows that they are all identical in structure and are spinels, Co_3O_4 being represented by $CoCo_2O_4$ or $CoO \cdot Co_2O_3$. The lattice parameter a of the spinel structure is 8.108 Å. They are undoubtedly cobaltites rather than mechanical mixtures of Co_3O_4 with MgO, ZnO, or NiO. (*C.A.*)

Nature of hardness and the hardness of metals. C. H. DESCH AND H. O'NEILL. *Trans. Amer. Soc. Steel Treating*, **16** [3], 483 (1929); for abstract see *Ceram. Abs.*, **9** [12], 1098 (1930). E.P.R.

Sodium metasilicate pentahydrate, a new industrial alkali. ANON. *Can. Chem. Met.*, **15** [1], 34 (1931).—It is now possible to produce a sodium silicate of quick solubility which is at the same time granular and free-flowing. Its chemical and physical properties class sodium metasilicate as having a larger percentage of available alkali present for detergent purposes than any of the other alkalis at present in use. The new alkali will find a place in the production of cleaning compounds. Metasilicate of soda does not etch metals due to the protective action of the colloidal silica. E.J.V.

Odd applications of minor alkali metals. ANON. *Ceram. Age*, **16** [3], 166–67 (1930); see also *Ceram. Abs.*, **9** [10], 832 (1930). R.G.M.

Analysis of chrome ores: A method for determining and separating chromium, iron, silicic acid, lime, and magnesia. T. R. CUNNINGHAM AND T. R. MCNEILL. *Ind. Eng. Chem.* [Anal. Ed.], **1** [2], 70–72 (1929); *Feuerfest*, **6** [10], 153 (1930).—Fuse 1 g. of chromium with 8 g. sodium peroxide in an iron crucible, cool, boil with dilute sulphuric and nitric acid, add 0.5% solution of silver nitrate, some potassium permanganate, and ammonium persulphate (until complete oxidation of chrome) and boil. Add 10% sodium chloride and after the disappearance of color boil 5 to 10 minutes to remove all chlorine. Cool and add phosphoric acid and a surplus of a normal 10th iron ammonium sulphate solution $2H_2CrO_4 + 6FeSO_4 + 6H_2SO_4 = Cr_2(SO_4)_3 + 3Fe_2(SO_4)_3 + 8H_2O$. Titrate with a normal 10th $KMnO_4$. Determination of iron and alumina: heat $^1/_2$ g. with H_2SO_4 and perchloric acid until SO_3 vapors appear or fuse

with a mixture of soda and borax. Heat for about 20 minutes to 1100°C and dissolve in dilute HCl and H_2SO_4. Concentrate the solution to 40 cc., treat with methanol (to volatilize boron) and HCl, and heat until the appearance of SO_3 vapors. After cooling, dilute with water, heat until the salts are dissolved, and add several cubic centimeters of H_2SO_4. Filter off silica, heat to redness, and weigh. Treat filtrate of SiO_2 with HNO_3 and boil. Add ammonium chloride and ammonia, dissolve in hot H_2SO_4, cool, and precipitate iron and titanium with 6% "copperron." Filter, wash with dilute H_2SO_4, heat to redness, and dissolve in dilute HCl. The iron is determined by the method of Zimmermann-Reinhard. If titanium is determined, fuse oxides heated to redness with potassium pyrosulphate, dissolve in H_2SO_4, and determine titanium colorimetrically. The filtrate of "copperron" sediment contains alumina and chrome; concentrate to 40 or 50 cc., add 100 cc. of HNO_3, concentrate by evaporation to 60 cc., add potassium chlorate to the hot solution till color changes to red-yellow: a sign that chrome is present in its 6-valenced form. Alumina is precipitated as hydroxide by ammonia. The Al_2O_3 contains some Cr_2O_3 and P_2O_5. Fuse with soda to determine chrome present in alumina, dissolve in water, and determine chrome colorimetrically. Determination of lime and magnesia: acidify filtrate of iron and alumina, concentrate to 150 cc., cool, treat with ammonium phosphate and ammonia, filter, and heat residue to redness. It contains lime, magnesia, some manganese, and small quantities of silicic acid. Dissolve in hot HCl, filter silica, and subtract its weight from the weight of $Mg_2P_2O_7$. Add 10 cc. of H_2SO_4 to the SiO_2 filtrate, evaporate till the appearance of SO_3 vapors, treat with 5 cc. H_2O and absolute alcohol. The $CaSO_4$ is filtered off, washed with alcohol, dissolved in HCl, and mixed with ammonium oxalate. The alcoholic filtrate of $CaSO_4$ is evaporated till SO_3 vapors appear. Cool and dissolve the residue in HNO_3 and determine the manganese in the solution by the bismuth method. M.V.K.

Rapid and sensitive method of detecting silica. F. Feigl and H. Leitmeier. *Mineralog. petrog. Mitt.*, **40** [1 and 2], 1–5 (1929).—The method depends upon the formation of a complex silicomolybdate. The mineral is fused in a platinum vessel with sodium carbonate. The resulting melt is dissolved in dilute nitric acid, and the molybdate solution added, the mixture heated for a short time, cooled, and a few drops of a 25% solution of chlorbenzidine hydrate added. On the addition of an alkali acetate the silicomolybdate is formed. G.R.S.

Modified method for decomposing aluminous silicates for analysis. A. N. Finn and J. F. Klekotka. *Ceram. Age*, **16** [3], 158–59 (1930); see also *Ceram. Abs.*, **9** [8], 676 (1930). A.E.R.W.

Structure of silicates. W. L. Bragg. *Jour. Soc. Glass Tech.*, **14** [55], 295–307 (1930); *Trans. Faraday Soc.*, **25**, 291–314 (1929); for abstract see *Ceram. Abs.*, **10** [1], 73–75 (1931). G.R.S.

Volumetric determination of silicic acid in silicates. N. A. Tananaev and A. K. Babko. *Z. anal. Chem.*, **82**, 145–50 (1930); for abstract see *Ceram. Abs.*, **10** [1], 25 (1931). (*C.A.*)

Conversion of quartz of different grain-size into silica-stone in presence of various fluxes. H. Salmang and B. Wentz. *Chem. Zentr.*, **ii**, 3175 (1929); for abstract see *Ceram. Abs.*, **9** [12], 1101 (1930). (*B.C.A.*)

Calcium perchromate. A new type of red perchromate. J. A. Raynolds and J. H. Reedy. *Jour. Amer. Chem. Soc.*, **52** [5], 1851–53 (1930).—A solution of red perchromic acid was prepared by the action of 30% hydrogen peroxide on freshly-precipitated chromium hydroxide at temperatures near 0°C. Calcium perchromate is formed at low temperatures, either by the action of 30% hydrogen peroxide on saturated calcium chromate, or by the action between calcium acetate and red perchromic acid solutions.

Analysis of calcium perchromate indicates the formula $Ca_3Cr_2O_{12}\cdot 12H_2O$. A mechanism for the formation of chromates from chromium hydroxide by means of alkaline peroxides is suggested. R.G.M.

Modification of glycerol method for determination of free lime. G. E. BESSEY. *Chem. & Ind.*, **49** [35], 360 (1930).—The glycerol extraction methods of determining free lime in cements and sand-lime brick are discussed. A modification is described in which the free lime is extracted by glycerol alone. For this purpose, glycerol is required which is not less than 99.2% pure and is free from any acidity. In making the determination, sufficient sample to give not more than 0.05 g. of free lime is added to 20 cc. of glycerol and allowed to remain for 24 hr. at 60 to 80°C. The mixture is then titrated with a standard solution of benzoic acid using phenolphthalein as indicator. A standard 0.1 *N* solution of benzoic acid in anhydrous ethyl or methylated alcohol is used for the titration. The method is simpler to carry out than methods hitherto described. The applicability and accuracy of the methods are briefly described. W.L.

Revised procedure for the determination of uncombined lime in Portland cement. WILLIAM LERCH AND R. H. BOGUE. *Ind. Eng. Chem.* [Anal. Ed.], **2** [3], 296–98 (1930); *Stahl Eisen*, **50** [44], 1549 (1930).—A revised procedure for the determination of uncombined lime in Portland cements by the ammonium acetate titration method is presented. Various factors which bear upon the precision of the test are discussed. A curve is given which shows that the percentage average deviation from the mean varies with the mean value for uncombined lime. The probable errors are determined and a curve is given which shows the probable error of any group from the mean, at any uncombined lime content up to 7%. R.G.M.

Thermal expansion tests on fused alumina, bauxite, and diaspore. ANON. *Ceram. Age*, **16** [3], 157 (1930); for abstract see *Ceram. Abs.*, **9** [9], 745 (1930). R.G.M.

Determination of magnesium in Portland cement, etc., by the use of 8-hydroxyquinoline. J. C. REDMOND AND H. A. BRIGHT. Bur. Stand., *Jour. Research*, **6** [1], 113–20 (1931) RP 265; Bur. Stand., *Tech. News Bull.*, No. 164, p. 119 (1930).—A procedure is given for the precipitation of magnesium by the use of the reagent 8-hydroxyquinoline and the titration of the acid solution of the precipitate with standard bromate-bromide solution. The method is accurate and much more rapid than the standard phosphate method. R.A.H.

Determination of uranium. P. N. DAS-GUPTA. *Jour. Indian Chem. Soc.*, **6**, 763–69 (1929); *Analyst*, **55**, 154–55 (1930).—U is precipitated from solution by tannin as a bulky chocolate-brown complex in presence of ammonia and ammonium acetate. The precipitate is ignited and weighed as U_3O_8. In very dilute solution tannin (and also gallic and resorcyclic acids) forms a brown color which may be used for the colorimetric estimation of U. See following abstract. H.H.S.

Gallic acid as reagent for titanium. P. N. DAS-GUPTA. *Jour. Indian Chem. Soc.*, **6**, 855–63 (1929); *Analyst*, **55**, 294 (1930).—Ti can be detected by the reddish-yellow coloration given by addition of gallic acid and sodium acetate. See preceding abstract. H.H.S.

Report on hydrogen-ion determination. C. H. BAILEY. *Jour. Assn. Official Agr. Chem.*, **13**, 444–45 (1930).—It is recommended that either the hydrogen electrode or the quinhydrone electrode be used in p_H determinations. H.H.S.

Possible sources of error in p_H determination. L. FLETCHER AND J. B. WESTWOOD. *Chem. & Ind.*, **49***T*, 201–203 (1930).—The influence of temperature, platinizing of electrodes, method of titration, and source of hydrogen is each in turn considered. H.H.S.

Determination of titanium as phosphate. J. C. GHOSH. *Chem. & Ind.*, **49**, 327 (1930).—The Na_2CO_3 fusion of the ore or clay is treated with boiling water to dissolve aluminates and silicates. The sodium titanate in the residue is dissolved in acid and when boiled, precipitates as metatitanic acid. This is dissolved, the solution is made neutral with NH_4OH, and Ti precipitated and weighed as phosphate. H.H.S.

Quantitative determination of radium in refractory substances. R. G. FULTON. *Jour. Assn. Official Agr. Chem.*, **13**, 497–503 (1930).—Fusion with Na_2CO_3 or treatment with HF brings the radioactive material into solution, whence it may be determined by Sale's or other emanation methods. H.H.S.

Meaning of the crystal. WILLIAM HENRY BRAGG. *Jour. Frank. Inst.*, **210** [1], 9–14 (1930).—Address at the Medal Meeting, May 21, 1930. The "aim of scientific research is to connect the properties of a substance with the design of its construction." For the arrangement of atoms and molecules in a solid, this design is revealed by X-ray analysis. M.A.E.

Formation and growth of crystals. W. E. GIBBS. *Chem. & Ind.*, **49**, 217–18 (1930).—Formation of crystals takes place in two stages: formation of nucleus, and growth of nucleus in the medium. These two factors are considered separately. The concluding portion of the paper deals with crystallization in practice. H.H.S.

Nature of the base-exchange material of bentonite, soils, and zeolites, as revealed by chemical investigation and X-ray analysis. W. P. KELLEY, W. H. DORE, AND S. M. BROWN. *Soil Sci.*, **31** [1], 25–55 (1931).—The data seem to justify the definite conclusion that the substances composing the colloidal material of the soils that have been investigated are not amorphous, but are composed chiefly of crystalline substances. The replaceable bases occur not only on the surface of colloidal particles but also on the interior of the crystals. The base-exchange substances are true chemical compounds. The replaceable bases are not merely adsorbed on the surface of the particles, rather the bases are an integral part of the chemical constitution of the crystals. The data clearly establish the fact that the inorganic soil colloids are not zeolites. These colloids apparently belong to the group of minerals known to mineralogists as clays. Certain of the better-known clay minerals, *e.g.*, kaolinite, and the less well-known anauxite, are hydrogen aluminium silicates which do not possess important base-exchange powers. The montmorillonite-beidellite group of clay minerals, which characterizes the bentonites, are essentially crystalline magnesium aluminium silicates. The Cecil colloid represents one of the oldest soil formations on the American continent. It has been derived from igneous parent material, either granite or rocks that are closely related to the granites. This colloid is characterized by a relatively low base-exchange capacity and low total base content. This colloid is distinctly acidic, and is closely related to the halloysite type of clays. Halloysite contains notable amounts of replaceable H ions, and the same is true of the Cecil colloid. The chief replaceable base of normal soils is usually calcium. This is probably because of two facts: (1) calcium ions possess a relatively high energy of replacement, and (2) the soil solutions which come into contact with the colloidal particles contain more or less dissolved calcium derived from the weathering of various calcium minerals. G.R.S.

X-ray examination of castings. V. E. PULLIN. *Foundry Trade Jour.*, **44** [751], 23–24 (1931); *Sci. Amer.*, **144** [1], 34–39 (1931); *Elec. Rev.*, **108** [2772], 78–79 (1931); *Mech. World*, **89** [2296], 15–17 (1931).—In general, X-rays might be applied to engineering in two ways, (1) in determining the lack of homogeneity of structure by a method called radiography, and (2) to study the fine structure of materials. X-ray spectrum-analysis, however, if developed, might have the greatest possible value in engineering. Practical applications of spectrum analysis and application to welding are discussed. The practical applications of radiography are described. A discussion of various

phases of the practical application of X-rays in general is given. See also *Ceram. Abs.*, **9** [10], 882 (1930). H.W.A.

Prism size and orientation in minimum deviation refractometry. L. W. TILTON. Bur. Stand., *Jour. Research*, **6** [1], 59–76 (1931) RP 262.—An investigation of the optical error in the pointing of telescopes, and of variations therein with width of objective aperture, indicates that the effect of marginal aberration is often sufficiently deleterious to seriously impair the advantages which should result from the use of the larger apertures. It is concluded that large telescope apertures and special procedures for securing accuracy in prism orientation are unnecessary in minimum-deviation measurements leading to an approximate precision of P.E. = $\pm 1 \times 10^{-6}$ in computed index of refraction. R.A.H.

Scattering light by dielectrics of small particle size. G. F. A. STUTZ. *Jour. Frank. Inst.*, **210** [1], 67–85 (1930).—An apparatus is described for determining angular distribution of scattered light. Depolarization, unlike intensity, follows the theoretical values of Blumer. M.A.E.

Friction of dry solids in vacuo. P. E. SHAW AND E. W. L. LEAVEY. *Phil. Mag.*, **10** [66], 809–22 (1930).—The relation of the friction of dry solids to their characteristic properties has been studied by means of friction in a vacuum chamber surrounded by a heating coil. The term "coefficient of friction" must be defined in terms of the history and physical condition of the reacting surfaces. M.A.E.

Combustion radiation and the Planck quantum theory. III. Laws of energy distribution and the distribution of energy of combustion radiation. W. J. WOHLENBERG. *Mech. Eng.*, **52** [11], 915–18 (1930).—W. discusses the above laws giving the distribution equations for thermal equilibrium accompanied by suitable curves. **IV. Energy process in the interim between the beginning and the end of a reaction.** *Ibid.*, 981–83 (1930). **V. Application of Planck quantum theory.** *Ibid.*, **52** [12], 1075–80 (1930).—W. states that the question which prompted the investigation was this: What fractional part of the total energy released in a combustion process could possibly be radiated in quanta of such magnitude that the effect of such radiation is felt outside of the infrared zone of the spectrum? The application of the question to the range of X-rays is discussed. The development of Planck's law to its final form is given:

$$\mu_\nu = \frac{8\pi \frac{h\nu^3}{c^3}}{e^{h\nu/kT} - 1}$$

This equation fits the experimental curve throughout the range of wave-lengths. The curves are given and the equation and its modifications are discussed. **VI. Planck theory of radiation applied to the constant-pressure furnace cavity.** The radiation equations for certain cases are set up and explained. For Parts I and II see *Ceram. Abs.*, **9** [12], 1083 (1930). H.W.A.

Improved apparatus and method for the analysis of gas mixtures by combustion and absorption. MARTIN SHEPARD. Bur. Stand., *Jour. Research*, **6** [1], 121–67(1931) RP 266.—This paper describes an improved volumetric apparatus for the analysis of gases by combustion and absorption methods. R.A.H.

Automatic gas analysis apparatus dependent on thermal conductivity of gases and its industrial use. P. JARRIER. *Fuel Sci. Prac.*, **9** [10], 458–62 (1930); for abstract see *Ceram. Abs.*, **9** [7], 584 (1930). R.G.M.

"Inner" specific heat of substances. I. WITOLD JAZYNA. *Z. Physik*, **57**, 341–44 (1929).—The difference between heat of dissociation (C_z) and heat of combustion (C_μ) is designated as the "inner relative heat" (C_r). The "inner absolute specific

heat" (C_s) is defined as the difference between the ordinary specific heat (C_x), the inner relative specific heat and the work of expansion. $C_s = C_v$ at $T = 0$. The absolute specific heat depends upon mass and molecular weight. The "heat molecular weight" (m') is that part of the molecular weight (m) effective in energy changes; $m' = \theta m$. Values for θ are given and from these C_s is calculated for various gases. (*C.A.*)

Heat of formation of water. FREDERICK D. ROSSINI. Bur. Stand., *Jour. Research*, **6** [1], 1–35 (1931) RP 259.—The procedure employed in the present investigation was to determine directly the quantitative correspondence between the energy liberated by (1) the reaction of hydrogen and oxygen to form a weighed mass of liquid H_2O, and (2) a measured quantity of electrical energy using the calorimeter as the absorber of the two quantities of energy and its temperature rise as the comparator. The data of two sets of experiments give for the heat of formation of liquid H_2O, at 25°C and a constant pressure of 1 atmosphere, 285,890 joules per mole (18.0156 g.). See also *Ceram. Abs.*, **9** [5], 387 (1930). R.A.H.

Evaluation of experimental results. L. ZIPPERER. *Gas Wasserfach*, **72**, 945–48 (1929).—A mathematical treatment of errors in measurements is given. (*C.A.*)

Solving ceramic calculations by the graphic method. J. WOLF. *Ceram. Age*, **16** [3], 146–49; [4], 215–18 (1930); for abstract see *Ceram. Abs.*, **9** [12], 1100 (1930). A.E.R.W.

Application of the new methods of the calculus of variations to some problems in the theory of elasticity. N. M. BASU. *Phil. Mag.*, **10** [66], 886–904 (1930).—The method of the calculus of variations leads to a direct determination of the torsion function and therefore to the strain and stress at any point. M.A.E.

Fitting observations to a curve. NORMAN CAMPBELL. *Phil. Mag.*, **10** [66], 745–58 (1930).—The simplified form of the method of least squares described by Condon, Birge, and Shea is applied to the method of zero sum with some general considerations of the problem of curve fitting. M.A.E.

Use of azeotropic data for calculating general properties of binary systems. CLYDE ALLEN. *Ind. Eng. Chem.*, **22** [6], 608–609 (1930).—A. offers a practical method for gaining information concerning the many systems which deviate considerably at finite concentrations from Raoult's law, yet not sufficiently to form two liquid phases. Partial pressures and related properties may be estimated for the entire range of composition of binary constant-boiling mixtures. R.G.M.

Mechanism of spark discharge. LEONARD B. LOEB. *Jour. Frank. Inst.*, **210** [1], 15–30 (1930).—The mechanism of spark discharge postulated by Townsend as due to ionization by positive ions will explain the sparking condition, providing in uniform fields of 3×10^4 volts it is possible to build up nonuniform local fields due to space charges of about 1.5×10^5 volts/cm. This requires a higher value of α than that assumed from Townsend's data. The question is being experimentally investigated. M.A.E.

BOOKS

Chemistry of the Colloidal State. J. C. WARE. Pp. xiv + 313. J. Wiley and Sons, New York, 1930. Price $4.50. Reviewed in *Chem. & Ind.*, **49**, 368–69 (1930).—Colloidal solution, sedimentation, and nonelectrical interfacial phenomena, turbidity, colloidal suspensions, electrical interfacial phenomena, colloid mills, emulsions, gels, etc., are described. H.H.S.

Story of Silica Gel. SILICA GEL CORP., Baltimore, Md. 52 pp. *Gas Age-Rec.*, **67** [2], 70 (1931).—This book gives a nontechnical explanation of what silica gel is and what it accomplishes. E.J.V.

Physical Chemistry of Metallurgical Reactions. (Physikalische Chemie der Metallurgischen Reaktionen.) FRANZ SAUERWALD. Julius Springer, Berlin. 142 pp. Price

15 Rm. Reviewed in *Mining & Met.*, **12** [290], 20 (1931).—S. presents the theoretical framework of the extraction of metals and considers the value of exact methods in practical metallurgy. The first section reviews the theory of chemical reactions and their quantitative treatment with emphasis upon the thermodynamics of reactions, the phase rule, the concept of affinity, and the laws of mass action. The reactions that underlie the extraction of metals are considered and the available quantitative data upon these reactions are given. In the final section the connection between the exact theory and technical processes is elucidated by the reactions in the blast furnaces and the steel processes, by the direct zinc process and by electrometallurgical processes. E.J.V.

Statistical mechanics for students of physics and physical chemistry. J. RICE. With foreword by F. G. Donnan. Pp. x + 333. Constable & Co., London, 1930. Price 18s. Reviewed in *Chem. & Ind.*, **49**, 369–70 (1930).—The modern statistical theory is based on the theory of probability. Individual theories are associated with the names of Gibbs, Planck, Bose, Einstein, Fermi-Dirac, Brillouin, while Kar, Mazumdar, and Saha call in question each and all of these statistics. H.H.S.

Encyclopedia of Technical Chemistry. VI. (Enzyklopädie der technischen Chemie.) F. ULLMANN. Urban and Schwarzenburg, Berlin and Vienna, 1930. 844 pp. Rm. 45.00. Reviewed in *Tonind.-Ztg.*, **55** [4], 60 (1931).—This volume discusses the development of the potassium salt industry and mining and refining methods. Several chapters are devoted to catalyses, crystallization apparatus, coolers, and the obtaining and use of low temperatures. For Vol. V see *Ceram. Abs.*, **10** [2], 153 (1931). M.V.K.

German-English-Italian Technical Dictionary. (Deutsch-englisch-italienischer Techno-Diktionär.) HUBERT HERMANNS. Reviewed in *Feuerfest*, **6** [11], 171 (1930); see also *Ceram. Abs.*, **9** [12], 1115 (1930). M.V.K.

Condensed Chemical Dictionary. ANON. Chemical Catalog Co., New York. Reviewed in *Glass Ind.*, **12** [2], 43 (1931); *Ceram. Ind.*, **16** [2], 202 (1931); see also *Ceram. Abs.*, **9** [11], 989 (1930). E.J.V.

PATENTS

Treating kaolin, etc. R. ILLNER. Brit. 338,726, Jan. 14, 1931. The physical properties of finely-divided siliceous mineral substances such as clay, kaolin, diatomaceous earth, and sericite earth are improved by suspending them in a liquid and causing them to adsorb a slightly soluble salt such as calcium sulphate or sulphite by stirring the suspension in the presence of the salt, which may be formed *in situ*. *E.g.*, a kaolin suspension coagulated by milk of lime is neutralized with sulphuric acid, bleached while stirring with sodium hydrosulphite and sulphuric acid, neutralized while stirring with milk of lime, and filter pressed and dried after the addition of ultramarine; and a kaolin suspension coagulated by aluminium sulphate is bleached while stirring with sodium hydrosulphite and sulphuric acid, neutralized with milk of lime, and then further treated as above. Any calcium sulphite or sulphate formed from the hydrosulphite will assist the adsorption process. Instead of ultramarine, Indanthrenic blue may be used to improve the color of the kaolin.

Treating kaolin. R. ILLNER. Brit. 338,730, Jan. 14, 1931. The process described in the parent Specification, wherein kaolin is bleached and caused to adsorb calcium sulphate, is carried out by stirring sodium hydrosulphite into an acid-reacting suspension of kaolin, blowing air, etc., into the suspension to oxidize excess of hydrosulphite, and then adding calcium hydroxide until the suspension is nearly neutral. Oxidation may be assisted by addition of a catalyst such as sodium nitrate. A blue vat dyestuff may be added after addition of sodium hydrosulphite but before oxidation, or an

acid- and alkali-fast organic vat dyestuff such as Indanthrenic blue be added after formation of calcium sulphate.

Treating silicates. F. JOURDAN. Brit. 339,028, Jan. 21, 1931. In decomposing natural silicates, such as leucite, volcanic tuffs, peperino, pozzuolana, china clay, and silicates of magnesium and aluminium, with an acid, such as hydrochloric, sulphuric, or nitric acid, in order to reduce to a minimum the silica content of the solution obtained, the operation is performed at a high temperature, *i.e.*, above 100°C, and to the reaction liquor is added a quantity of the same salt as is produced, the solution obtained being finally acidified to a point at which the salts in solution begin to separate. The process is preferably performed in a pressure vessel provided with a stirrer, *e.g.*, at 10 to 15 atmospheres, the acid being previously heated and the temperature being maintained by the heat of the reaction.

General

Heat conductivity of boiler scale. C. EBERLE. *Arch. Wärmewirt.*, **10**, 334; *Mech. World*, **88** [2270], 11 (1930).—E. discusses the failure of boiler-tubes due to the deposition on their inner surfaces of insoluble salts in the form of scale. He gives in tabular form a comparison of eighteen cases of boiler-scale formation, with a chemical analysis of the scale in each case together with details as to its specific weight, γ', and specific volume, γ. From the last two properties he deduces the porosity p of the scale as given by the formula $p = \frac{100\ \gamma' - \gamma\%}{\gamma}$. The porosity of the scale determines to a large degree its heat conductivity, so that porous scales are more likely to cause burning of the tubes due to overheating. Scales rich in calcium sulphate are less porous and accordingly are better conductors than those rich in silicates. Scales of high porosity have caused burning of the tubes when the thickness of the scale has been only 0.5 mm.

E.P.R.

Sodium metasilicate: its place among industrial alkalis. JAMES G. VAIL. *Chem. Met. Eng.*, **37** [12], 736–40 (1930).—Of several hydrates of sodium metasilicate, only one ($Na_2SiO_3 \cdot 5H_2O$) is prepared in the form of a free-flowing granular product. This salt melts in its water of crystallization at 71.5°C, the solution being miscible in water in all proportions. The dry salt absorbs moisture from the air and then reacts with CO_2. Washing machinery of various types, such as dish washers, bottle machines, and metal washers which have become incrusted with reaction products of hard water and alkalis, not only fail to accumulate such deposits when metasilicate is used with the same hard water but the old scale tends to soften and come off. G.R.S.

Lighting plus vision equals seeing. M. LUCKIESH AND F. K. MOSS. *Trans. Illum. Eng. Soc.*, **25** [9], 807–25 (1930).—The science of seeing, that is, of partnership between lighting and vision, could not develop until the development of artificial illumination. Individuals cannot judge the adequacy of illumination by their ability to see, as the eyes will compensate for poorer light by increased expenditure of energy. An experiment on vision in inadequate light showed increasing production with decreasing ability to produce; a situation resulting in fatigue and lose of nervous energy. A visual test has therefore been devised in which the subject has little control over the visual energy expended. The test may be obtained as a pack of 52 cards or in book form. M.A.E.

Engineering aspects of electric lighting. JOHN W. LIEB. *Trans. Illum. Eng. Soc.*, **25** [7], 637–62 (1930).—Among the subjects treated in this brief survey are illuminants, glare, direction, intensity and color of light, daylight equivalents, commercial lighting glassware, and accessories. M.A.E.

Mechanical side of glazing. W. B. STEPHENS. *Ceram. Age*, **15** [2], 100 (1930).—A strong suction in the clay from baking in a red heat, and brushing on the glaze will do much to develop a perfect union between the body and glaze. A cure for rolling of the glaze in firing is to have glaze and body of a dissimilar chemical composition. Fritting will do much also to overcome this difficulty. Reduction of alkalis in the glaze will help to solve the crazing problem. A.E.R.W.

Chemical products and highway progress. T. W. DELAHANT. *Chemicals*, **35** [2], 10 (1931).—In France especially, and certain other foreign countries, sodium silicate is used for curing, hardening, and water-proofing concrete roads; for binding macadam roads, and as a dust palliative. The U. S. production of this chemical advanced from 287,000 T. (40° B basis) in 1919 to about 5,000,000 T. in 1927. G.R.S.

Putting flowerpots into modern production. ANON. *Ceram. Age*, **16** [4], 209–10 (1930).—A description is given of a 150-ft. tunnel kiln pottery specializing in flowerpots. Approximate capacity is 40,000 pots per day. Illustrated. A.E.R.W.

Salvaging of waste metals a billion dollar industry. ANON. *Ceram. Age*, **16** [2], 103–104 (1930).—An interesting and complete discussion of the salvaging of waste metals in many industries is presented. R.G.M.

Investigation of heating rooms with direct steam radiators equipped with enclosures and shields. A. C. WILLARD, A. P. KRATZ, M. K. FAHNESTOCK, AND S. KONZO. Univ. of Ill., *Bull.*, No. 192 (June, 1929). A.E.R.W.

Fireclay mining in England. E. W. POTTS. *Ceram. Age*, **16** [3], 153–57(1930).—There are two broad classifications of working clay or coal, *i.e.*, (1) pillar and stall and (2) longwall work. In the former the clay is obtained in two distinctive operations, while in longwall working only one operation is necessary. Fire clay is difficult to cut but there are several mines where fire clay is being machine-cut successfully. There are three types of machines, classified as the "bar," the "disk," and the "chain" machine. All types are similar in construction, the most characteristic difference being in the cutting member. To deal with water in a mine is not difficult under normal circumstances. In some localities, of which South Staffordshire is one, the cost of removing the water is a serious part of the cost of winning the clay. Rams or turbine motor-driven pumps are universal for shaft pumping in modern mines. The ventilation of a mine has to be effected by artificial means. This is done by the action of a mechanical centrifugal fan producing a positive or negative pressure, and thus acting as a compressing or exhausting fan. A.E.R.W.

American Refractories Institute recommends code of ethics. ANON. *Ceram. Age*, **15** [4], 222 (1930).—The A.R.I. has recommended a code of ethics to the refractories industry to eliminate unfair trade practices, competition, and economic waste. The code is given in detail in the article. A.E.R.W.

Feldspar, Commercial Standard CS23–30. ANON. *Commercial Stand. Monthly*, **7** [6], 191 (1930); for abstract see *Ceram. Abs.*, **10** [2], 145 (1931). E.J.V.

Revision of the American standard illuminating engineering nomenclature and photometric standards. ANON. *Trans. Illum. Eng. Soc.*, **25** [8], 725–41(1930).—Definitions, units, symbols, abbreviations, equivalents, and conversion factors are given. M.A.E.

Code of lighting: factories, mills, etc. ANON. *Trans. Illum. Eng. Soc.*, **25** [7], 607–36 (1930).—This industrial lighting code has been prepared by the Illuminating Engineering Soc. as a revision of the code approved by the American Engineering Standards Committee, Dec. 31, 1921. It is divided into three parts: (1) advantages of good illumination, (2) suggestions and information, and (3) rules. Advantages lie in reduction of accidents and economy of operation. M.A.E.

Tile industry reduces cost of manufacture through standardization. MILTON J.

PHILLIPS. *Commercial Stand. Monthly*, **7** [5], 140–41 (1930).—With 20% deducted from overhead charges, the tile industry of the U.S., under the leadership of the Associated Tile Manufacturers reduced from 735 patterns to 115 and a dozen standards of quality have been reduced to three. Similarly, all indefinite words in tile terminology have been banned. E.J.V.

Difference between associations and institutes. A. F. GREAVES-WALKER. *Ceram. Age*, **16** [2], 106 (1930).—A discussion of the difference between associations and institutes is given. The former are made up entirely of those interested in production while the institutes are composed of producers and consumers. The associations are usually interested mainly in price whereas the meetings of institutes being composed of mixed groups, price arguments cannot come up. Research constantly is brought to the fore at these meetings. A.E.R.W.

Industry's need for publicity. ROSS C. PURDY. *Glass Ind.*, **12** [1], 13–14(1931); for abstract see *Ceram. Abs.*, **10** [2], 153 (1931). E.J.V.

Ceramics research program for 1931. G. A. BOLE. *Blast Fur. Steel Plant*, **19** [1], 158 (1931); see *Ceram. Abs.*, **10** [2], 155 (1931). E.J.V.

Employee as collaborator. ANON. *Corriere Ceram.*, **11** [12], 509 (1930).—Methods practised in factories for stimulating the interest of the employees in improving their work include conferences and discussions, technical libraries, letters of comment with pay check, etc. M.V.K.

Advantages of well-equipped plants. A. F. GREAVES-WALKER. *Ceram. Age*, **16** [5], 288 (1930).—The plants which have modern equipment and good selling organizations are able to continue operations despite the present business depression. A.E.R.W.

How safe is a factor of safety? J. DILOT. *Mech. Ene.*, **52** [11], 984–85 (1930). H.W.A.

Management of the small manufacturing plant. CROSBY FIELD. *Mech. Eng.*, **52** [10], 901–904 (1930). H.W.A.

Industrial silicosis. G. M. DYSON. *Ind. Chemist; Ceram. Age*, **16** [4], 220–21 (1930). A.E.R.W.

Is the potter's wheel passing? MARGUERITE JENKINS. *Ceram. Age*, **16** [4], 219–20 (1930).—J. points out that in one of the pottery studios of this country, the potter's wheel has become almost a thing of the past. Illustrated. A.E.R.W.

Clay products production. BUREAU OF CENSUS. *Brick Clay Rec.*, **78** [1], 36–38 (1931).—According to data collected in the Census of Manufacturers taken in 1930, the total output in 1929 of clay products (other than pottery) and nonclay refractories by manufacturers in the U.S. was valued at $297,413,023 (at f.o.b. factory prices), an increase of 1.6% and a decrease of 7%, respectively, as compared with reports for 1928 and 1927. Itemized and tabulated data are presented. E.J.V.

Canadian clay products industry. DOMINION BUREAU OF STATISTICS. *Brick Clay Rec.*, **78** [1], 40 (1931); *Can. Chem. Met.*, **15** [1], 35 (1931).—There were 199 firms with a capital investment of $37,662,108, operating in the clay and clay products industries in Canada during 1929, employing 6402 persons and earning a total of $6,839,895. The value of clay and clay products sold by Canadian producers during 1929 advanced 13.6% over 1928. Manufactures in Canada from imported clays amounted in value to $3,373,038 in 1929, an increase of 67% over 1928. E.J.V.

Porto Rican market for glass. DARWIN J. DEGOLIA. *Commerce Repts.*, **51**, 744 (1930).—There is a good demand at present for window glass. Types of glass in demand include plain glass, especially cheap lines of windows and doors, frosted, rough-surfaced frosted, and wire glass for doors and windows to complete the safety element in fireproof buildings. Statistics on imports are given. E.J.V.

Russian industrialization. R. M. KING. *Glass Ind.*, **12** [1], 4–5 (1931).—The greatest peace time engineering project of history is the present industrialization program in Russia, known as the Five Year Plan. K. discusses the comprehensiveness of this program, the efficiency with which it is being carried out, and the coöperative attitude displayed by the Russian people, showing how propaganda is being employed and how the program is being financed. Some of the specific projects of this plan are enumerated. For the manufacture of ceramic products the budget calls for a total capital investment of $145,000,000. E.J.V.

Refractory industry in Poland. ANON. *Corriere Ceram.*, **11** [12], 519 (1930).—Development of the refractory industry in Poland has been slow because of the insufficient protective tariff, lack of capital, and inadequate transportation facilities. The most important plants are located near Kilee and Cracow; their capacity of production for 1929 was 1,500,000 quintals. M.V.K.

Glass exports of Czechoslovakia decline. SAM. E. WOODS. *Commerce Repts.*, **52**, 805 (1930).—Exports of glass from Czechoslovakia during the first eight months of 1930 declined by about $3,735,000. Detailed data on exports are presented. E.J.V.

Progress in ceramics in the year 1929. M. MIELDS. *Chem.-Ztg.*, **54**, No. 84; *Fortschrittsber.*, 86–95 (1930). (*C.A.*)

Exhibition of the State Porcelain Manufacture in Berlin. CHARLOTTE STEINBRUCKER. *Sprechsaal*, **64** [2], 31 (1931).—A description of porcelain lamps of different styles, candelabra, chandeliers, vases, toys, and kitchen utensils exhibited by the State Porcelain Manufacture in Berlin is given. M.V.K.

Visit to the official laboratory of the society (French) and the exhibition of ceramic materials. ANON. *Céramique*, **33** [509], 195–206 (1930).—An illustrated account of a ceramic exposition is given. A draft regulator in which a gasometer bell operates the damper in the flue stack is of interest. A.E.R.W.

Technical excursion of the French Society of Ceramic Manufacturers to Switzerland. ANON. *Céramique*, **33** [513], 300–14 (1930).—A detailed account is given of a technical excursion June, 1930, in Switzerland. The manufacture of a great variety of products was inspected. These included brick, tile, sewer pipe, flue pipe, refractories, clinkers, tableware, and electrical porcelain. A.E.R.W.

BOOKS

Elementary Electricity. EDGAR P. SLACK. McGraw-Hill Book Co., New York. 279 pp. Price $2.00. Reviewed in *Elec. World*, **97** [5], 246 (1931).—The book is intended for use in vocational and industrial schools by students who have not studied electricity before and whose mathematical training may not have gone beyond arithmetic. The treatment is based on the modern electron theory and the student who continues his work in college should find few changes needed in fundamental ideas. G.R.S.

Bibliography of French Books on Industry and Technology, 1919-1930. (Bibliographie des Livres Français sur l'Industrie et la Technologie, 1919–1930.) ANON. Published by J. B. Baillière and Sons, Paris. 300 pp. Reviewed in *Elec. World*, **97** [4], 202 (1931).—This compilation lists the works in the French language concerning industry and technology which were published from 1919 to 1930 by fifteen firms. G.R.S.

Yearbook of Ceramists and Glassmakers of France. (Annuaire des Céramistes et Verriers de France.) ANON. Reviewed in *Glass Ind.*, **12** [2], 27 (1931); see also *Ceram. Abs.*, **9** [7], 595 (1930). E.J.V.

Index to A.S.T.M. Standards and Tentative Standards. ANON. Published by the A.S.T.M., Philadelphia, Pa., Sept., 1930. 115 pp. This pamphlet constitutes a

combined index to all A.S.T.M. standards and tentative standards in effect as of September, 1930. A complete list of the 427 standards and tentative standards herein indexed appears in the 1930 A.S.T.M. Year Book, and in both parts of the 1930 Book of Standards. The index is designed to be of service to those familiar with the Society's standards in locating any specification or method of test in the bound publications in which it appears. R.A.H.

Book Review

Ceramic Industry of Ontario. ROBERT J. MONTGOMERY. Ontario Dept. of Mines, 39th Annual Rept., Part IV. 182 pp. 100 illustrations. The value of clay products marketed in 1929 is $6,830,162 for Ontario and $13,222,476 for Canada. There are 145 plants in Ontario manufacturing building brick, drain tile, or hollow building block. Seventeen of these plants operate all the year. Twenty-five operate more than 7 months but less than 12 months per year and the rest operate less than 7 months per year. The manufacture of brick is being concentrated into fewer plants of larger production or several plants are operated by one company. Inefficient plants find operation difficult for the production of the plants of Ontario exceeds the demand. The more progressive plants with one exception are not over 20 years old. Some of the older plants have made brick for 100 years or more. The clays of Ontario may be divided into three groups: (1) Cretaceous, refractory, and stoneware clays of Northern Ontario which are not accessible for use being six or more miles from the railway. The type of country makes it difficult to build a motor road. (2) Queenston and Loraine shale which is used for the manufacture of brick, hollow building block, floor tile, and drain tile. (3) Glacial and Marine surface clays which are used for the manufacture of brick, hollow building block, flower pots, drain tile, sewer pipe, and conduits. The geologic and geographic distribution of these clays are given together with chemical and physical properties of the more important ones. The methods of manufacturing in Ontario by the soft-mud, stiff-mud, and dry-press processes are described and the more important technical points are discussed. The kind and efficiency of the equipment used is discussed and comparison is made with modern practice. At present there is no standard-sized brick in Ontario. A short description of each heavy-clay products plant is given, arranged by county. Other plants which manufacture refractories, silica brick, electric furnace products, special cements, pottery, Rockingham ware, floor tile, electrical porcelain, glass, enameled iron, and ground feldspar are listed and briefly described. Copies may be obtained by addressing the Ontario Department of Mines, Parliament Buildings, Toronto, Ontario. See also *Ceram. Abs.*, 9 [9], 797 (1930). ROBERT J. MONTGOMERY

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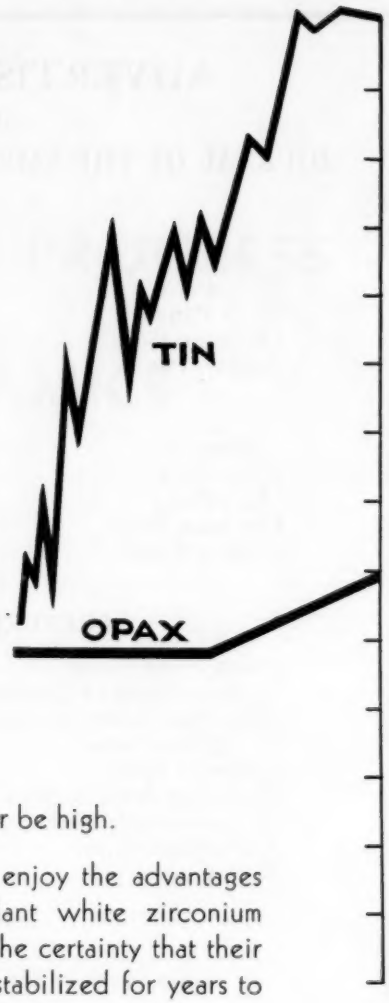

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Vol. 10 **April, 1931** **No. 4**

EDITORIALS

PRESIDENTIAL ADDRESS FOR THE THIRTY-THIRD ANNUAL MEETING OF THE AMERICAN CERAMIC SOCIETY[1]

BY EDWARD ORTON, JR.

Members of the AMERICAN CERAMIC SOCIETY,

Ladies and Gentlemen: A year ago, when listening to the admirable address of my predecessor,[2] the task of preparing a fitting message to the SOCIETY, then a year in the distance, seemed formidable enough. Now, the year having flown by seemingly with the speed of an airplane, and the occasion having actually arrived, the task seems impossible. The difficulty is not due to lack of suggestive material—quite the reverse, for there are many subjects I should like to discuss with you, any one of which might well occupy all the time that your indulgence would grant (or that courtesy to the able speakers who are to address you later would permit), that I must perforce limit myself to a very sketchy statement of a few of the matters that seem to me to be the most important.

[1] Presented at the Annual Meeting, AMERICAN CERAMIC SOCIETY, Cleveland, Ohio, February, 1931 (General Session).

[2] See *Bull. Amer. Ceram. Soc.*, 9 [4], 87–90 (1930).

The occasion might well lead me into a reminiscent mood. When you consider that thirty-three years ago, in a small lecture room in the Department of Geology in the Ohio State University, it was my great privilege to call to order and address the little group of potters and chemists who had come together to form a society for the study and development of ceramic science, the first meeting of its kind in the English speaking world, you will realize how strong is the urge to tell you, of this generation, something of those early days and to trace the marvellous progress which we of those days have witnessed, and which we may perhaps be pardoned for thinking has been in some degree due to our faith, vision, and efforts. But to yield further to this temptation would be fatal to any discussion of our present condition and the problems which confront us now. At least, I may be pardoned if I express the heart-felt pleasure I feel in greeting in this audience some few of the twenty-one Charter members, who have been spared through this third of a century and have come back, as I have, to renew their youth in the inspiration of this occasion.

Concerning the statistical facts as to the present status of the SOCIETY, its membership, its finances, its publications, and like matters, I shall touch very lightly. The Reports of the Secretary, the Treasurer, and the various Committees will deal with these matters in detail. All of you are familiar with the literature we are publishing, and the records of painstaking research which are being given to the world through that medium. Doubtless you all have your own ideas as to its adequacy. I know that many of you are from time to time quite frank about its inadequacy. I regard this as a happy and healthful sign. No true student or scientist is ever satisfied with himself or with others. He must, by the very nature of his mental mold, always be questioning the past and searching the future, and complacent acceptance of the present would mark the end of his growth or continued achievement. So, be dissatisfied always, but do not forget to strive always to bring a fuller knowledge and a wider vision to replace that which you condemn.

Two definite concrete steps have been taken this year which I confidently believe will increase the power and effectiveness of our organization. The first of these is the formation of a new division, the Materials and Equipment Division, which is to hold its organization meeting this very day. Some of you perhaps have not yet sensed fully the need of such a division, reasoning that all the divisions have in the past given place to papers and discussions on such topics, and that under that procedure new materials and new equipment have been brought forcefully to the attention of those most directly concerned with its use. On the other hand, ceramic materials and processes in the nature of the case are of such general use, in so many branches of our art, that members of all divisions should profit from more general diffusion or knowledge concerning them. And no one

can successfully deny that the classification and subdivision of knowledge is an inherent part of scientific progress. Chemists of the old school saw no reason for the formation of this SOCIETY, arguing that we were fundamentally chemists and should stay in the chemical fold. But we felt the need of the impetus which we should get from subdivision of the field of chemical engineering, and an intensification of attention to our special phase of it. The same process which has split our one time single body into seven divisions is still operating. Who would say that we have not gained by it? Each division now displays more papers, more studies, more discoveries, more pushing back of the frontiers of the unknown, each year than the whole SOCIETY did when it was one body. By the lessons of our own experience, as well as the universal testimony of all other organizations, we shall gain by subdividing and specializing in the future as in the past. And, we cannot resist this tendency if we would. So we should one and all welcome our new Division into our circle, and encourage its members to do their best to represent worthily their field, with full confidence that they will help us more than we can help them.

The second forward step is in the successful carrying out of the plan presented a year ago to form a new grade of membership, more or less honorary in nature, known as the Fellowship. I will not weary you with a repetition of the reasons which led to the presentation of this proposal. Suffice it to say that the SOCIETY by a nine-tenths majority of those voting adopted it.

The physical steps which were provided by the enactment for carrying the proposal into being have consumed a great deal of time and energy. Fortunately all concerned have coöperated splendidly. No one has shirked and the work has been done on schedule time. The preliminary or organization meeting of the Fellows was held on December 27, 1930, with a good attendance and a great and growing appreciation of the beneficial possibilities of the new body. The first general meeting of the Fellows took place last night, and the first public induction is to occur Wednesday evening.

It is too early yet to show any concrete advantage from the organization of this branch of our SOCIETY. As only about one-sixth of the members voted on the proposal, it is fair to assume that it is not yet clearly understood by a large majority of the members. Naturally, among them, there are many who do not visualize any need of it, or any benefit from it. There are many things which such a picked and chosen group can do, far too many to attempt to enumerate or discuss. The one big outstanding thing which I hope and expect it to do, is to give a rebirth to the spirit of idealism and self-sacrificing labor for the SOCIETY by its members. The founders and early members of the SOCIETY had this spirit in marked degree. With the passage of the years, with great increase in membership, with less

personal acquaintance among members, and the necessary centralization of much of the work in the central office, there has been a natural though regrettable weakening of this bond.

With the bringing together into one body, of not too great size, the picked men of the SOCIETY, the men who have most fully exemplified the ideals of productive scholarship, loyalty to the SOCIETY as evidenced by their work and sacrifices for it, and personal character as evidenced by the desire of their fellow members to honor them, it seems unavoidable that there will be a recrudescence of the old sacred flame which kindled and ennobled the members of a past generation. With that spirit we shall grow greater. Without it, we shall dwindle. If the Fellowship does not bring this about, what other body can? In short, I regard the Fellowship as the spiritual guardian of the SOCIETY, the preserver of its ideals, the stimulator of its pride, the radiant force of its inspiration, whose influence shall lead us always to higher levels of achievement in the future.

Passing now to another topic, I wish to undertake, as briefly as the subject permits, an appraisal of our status as an organization, not in a concrete sense, as concerning our bank balance or the pages we have published, but from a broader consideration of our objectives.

What were our original objectives, as developed in the first ten years of our existence? Primarily, they were two: (1) to break down the reserve between men engaged in similar work and get them to exchange thought freely with each other; (2) to create a technical literature for our profession, by which the whole world would be the gainer. The first of these was partly, perhaps largely, personal or selfish. The second was largely if not wholly unselfish and altruistic. How have we succeeded in these thirty-three years of labor?

	Volumes	Papers	Pages
Transactions	19	735	10,871
Journals	13	1210	10,980
Abstracts			5592
Indices			941
Bulletins			3340
Publications	23		3367
	55	1945	35,091

We have broken down the barriers of trade-secrecy, not wholly, but to a degree that you of this generation can but little visualize. To find two ceramists who would talk to each other of their work was, in the year 1898, all but impossible. In our twenty-one charter members, we had about all there were in the United States, and they came together warily, watching each other a little distrustfully, and guarding their utterances with great discretion. Contact with each other soon broke down this invisible barrier and a genuine love feast was on. The loneliness that each man felt

gave place to an affectionate comradeship, than which there is no lovelier thing in all the relations of man with man in this world.

We have developed research. There was little then and what was done was hidden in the vaults of the companies. Coöperative research in our field was unknown. Look at the flood of such work which annually pours through our Meetings, over our printed pages. Consider the small army of men who are devoting their lives to it.

We have developed education. In a sense, the educational institutions might justly claim that they have developed us. But after all, how could the twenty or more ceramic schools have developed into their present impressive importance, without the literature which we have assembled and published? How could their teachers and research men have functioned without the clearing house which we have afforded them? We have given them industrial contacts to test their laboratory studies. We have helped them to recruit their staffs from practically experienced personnel. We have put our shoulder to the wheel to help them secure government and state aid for their experiment stations. Remove the influence of the AMERICAN CERAMIC SOCIETY from the field and try to imagine, if you can, how the experiment in ceramic education would have progressed during these three decades.

May we not, then, justly say that we have been attaining through the years those initial objectives which we set for ourselves? May we not say more, that we have made a brilliant and impressively successful record, and that we have won the recognition and praise of the great technical societies in their respective fields of science and technology?

There is now urgent need of a reconsideration of our objectives. To the soldier or statesman, the attainment of one objective means the setting up of another. Nothing remains static in this world, nor in the great cosmos of which it is an infinitesimal speck. We must continue to grow and expand, or we shall inevitably shrink and die. Our early objectives have been so largely attained that there is a real and present danger that we may go stale if we do not address ourselves to a new task which will give outlet to our activities and put to a fresh test the initiative, driving force, and altruistic purpose which animated our early years.

What should the new objective be? Opinions may well differ upon this. I will give you my own. I think the SOCIETY should now definitely set itself to serve (more directly) the ceramic industries on their business side. They think of us now as a group of technical men, who read papers to each other. They do not visualize in us a powerful and resourceful ally to bring in more business or to make their present business more profitable.

What do the ceramic industries of the United States need? Most of all they need to develop unity of purpose, and ability to coöperate as a group for putting the ceramic industries boldly and broadly before the

people. Other groups are doing this in their fields, especially our leading competitors, steel, cement, chemical products, and wood products. They have been able to sink their internal differences and unite in common programs to boost their work. Not so with us.

The great groups of ceramic industries need aggressive leadership of national character to represent their products. They need representation in the places where standards are set and specifications are drawn. They need representation in government departments, where promotion plans are made and public questions are answered. They need sustained and intelligently developed publicity through which the people may be forced to learn the merits of what is produced, and the value of the services their products can render.

What has the AMERICAN CERAMIC SOCIETY done to bring about this unity of purpose and coöperation in the ceramic industries? Very little in any specific direction. Our mere existence has been a useful influence, though passive in character and, if these ideas are sound and practical and are generally recognized, why have we not stepped into the breach and made ourselves felt? Has it been lack of vision of the need and of our opportunity? In part, yes. But there are among us quite a few who have seen this picture and have lifted their voices, like the prophets of old, calling aloud in the wilderness. Chief among these has been our able Secretary, Mr. Purdy, who never loses a chance to express this idea. But, as a body we have not seen this picture, or if we have seen it, we have done little about it.

But, the one big obstacle which has held us back is not so much lack of vision as it is lack of resources. And why do we lack resources? Because we have not yet convinced business executives that we are anything more than a body of technical men.

We have made better technique possible. We have made research and its fruits available. Now, we must go further and show industry how to use research. We must translate research into new products and better products, and do our share by promotion to educate the public to accept and use them. When we can show plant managers and corporation heads that our work powerfully and directly aids in making new products and new markets, or even helps to hold their place against the aggressive inroads of competing industries, then they will not let us suffer for lack of resources.

Thus, as I vision it, the SOCIETY finds itself in a vicious circle. We cannot do things in a big way for lack of funds. We cannot get funds because we do not do things in a big way.

We have to find a way to break out of this circle. We have no reason for discouragement. The problem we face now is not one-tenth as difficult as that which we confronted when we organized thirty-three years ago.

Then, we had no friends on the business side. If they noticed us at all, it was only to laugh or sneer. We had no standing among the scientists. We had no numerical strength. We did not have great knowledge in our own technical field. Yet we did have something which enabled us to win this first big battle. We had a fixed faith in ourselves. We had a firm belief in the need of such an organization. And most important of all, we had an altruistic desire to benefit our industry, and through it to benefit the world. And so, like David, we faced the Goliath of industrial ignorance and went about our task.

And now, with every resource and power multiplied a hundred fold, can we look each other in the face and say we cannot do this thing? What we need to do is to start—to start with what we have and make some headway. What we need most of all is a rebirth of courage and self-confidence and (forgive me for saying it) a spirit of self-sacrifice for our cause. Nothing big is ever accomplished in this world, except when men forget themselves in their absorption in an ideal. Even when the ideal is bad, it may succeed for a time, by the united unselfish efforts of those who believe in it. An ideal cannot be killed by bayonets, or by ridicule. It can be met only by another ideal and a better one. The lessons of history will recall plenty of illustrations of this.

If I have convinced you that I am right in my diagnosis of the SOCIETY's position and that the only way out of it is to make ourselves increasingly useful and indispensable to the ceramic industries, and that the way to start is to start, then I have a suggestion as to what our first move should be. It is this: To secure adequate representation for the ceramic industries in the World's Fair in Chicago in 1933, which they call the Century of Progress.

The managers of this Exposition have taken the lesson of recent failures to heart and are proposing something quite different and very much better. It will be a unique thing among Expositions, in that it is being constructed upon a consistent coherent plan for illustrating the progress of the world in the last hundred years, through the development of science and its applications to man's needs. I will not attempt here to explain further, but the meeting here on February 27, will give all an opportunity to get a clear view of the immensity and importance of the plan.

The ceramic industries must participate in this great national affair. To absent themselves from it would be simply suicidal. To participate singly as competitors, without any effort to set themselves and their industry forward as a whole, would be almost as bad as to refuse to participate at all. What is needed is a ceramic building, built of ceramic products, to house educational exhibits and working models of what we have done in one hundred years to serve mankind. The SOCIETY cannot supply funds, but it can supply everything else—intelligence, energy, skill, in-

centive, and leadership. If we can make this project successful, we shall, by the same token, have taken the first and biggest step toward our new objective. The coöperation of the whole group of ceramic industries once begun will grow and we shall attain our coveted position in sponsoring that movement. Our opportunity is here. It remains to be seen whether we are big enough intellectually to see it, and big enough in leadership and spirit to grasp it.

Our National Problems

It seems to me that any organization of national scope, which seeks by its name to carry the implication that it speaks for the nation within its special field of knowledge, owes something to the nation, as well as to the industry which it represents, and the individuals who compose its membership. In short, I think we cannot divest ourselves of a certain responsibility to have views and to express them upon affairs which affect the solidarity and future of our country. A part of our thinking should be national.

The ceramic industries are one part, and a not inconsiderable one, of the national industrial system. If the United States as a whole is prosperous, we shall be prosperous. If it is depressed, we shall be depressed. It is well for every citizen to think on these matters. It is still more obligatory for great representative groups of citizens to think and to think constructively upon them. We should look thoughtfully into our economic system and take stock of where our country stands, and try to evaluate the forces which are at work, both for and against us.

The forces which are helping us in America to hold our place and to grow even more powerful in the world, are many. Here are some of them.

(1) A magnificent climate, ranging from sub-tropical to sub-arctic. All of us live when men can develop virile physiques and can work arduously, subject neither to the enervation of tropic heat nor the numbing struggle for mere existence against the eternal ice and snow.

(2) A vast and varied mineral wealth, as nearly all-inclusive as that of any nation.

(3) A soil of splendid fertility, whose possibilities under intensive agriculture are yet unvisioned.

(4) A water supply in our lakes and rivers of enormous extent and capable by conservation and treatment of supporting an immensely increased population.

(5) A wonderful coast line, replete with splendid harbors on three sides of our domain. Augmented by the canalization of the St. Lawrence whereby the Great Lakes become virtually ocean ports, we will have ocean

commerce on the greater part of all four frontiers. Our coast-wise waterborne traffic and our rapidly increasing river transportation are already of monumental proportions. We have the most comprehensive rail transportation system in the world, with auxiliary systems, by motor transport on a system of national highways of unparalleled extent, and a rapidly expanding air transport service.

(6) And last, a people endowed by nature with splendid physique, tremendous energy, and unequalled initiative.

Added to these natural endowments, we have created three other forces. First, the most highly developed industrial system of the world. We are the originators of mass production, the envy and despair of every other civilized people. Second, we have an educational system unequalled in the world in its ability to extend education to the masses. Third, we have the greatest wealth and financial resources of any nation.

These claims are in no respect overdrawn. They must be admitted by any who will stop to consider the subject.

On the other hand, there are forces which are hindering us and which must be overcome, if we are to rise to our opportunities and achieve the dominant place in the world, which our unequaled endowment places within reach. Some of these are as follows:

(1) A provincial self-satisfaction with things American. Not many of us are willing to appraise dispassionately the best in other nations, or try to adopt their methods where they excel our own.

A marked disinclination to meet world changes or to think in international terms.

A hide-bound political system, so slow acting and inelastic as seriously to hamper direct responsibility of the government to the people.

An archaic legal and judicial system, a hundred years behind the times. We adopted it from England 150 years ago and have not changed it in any vital way since. England, meanwhile, has constantly altered and improved this system, has never been afraid to discard what became obsolete, and has thus kept its law abreast of modern conditions. We have never discarded anything and have rendered the whole more and more unworkable by myriads of amplifications and precedents until American law and justice are flouted at home and ridiculed abroad.

An organization of society which favors the massing of enormous wealth in the hands of the few. According to the National Bureau of Economic Research, 5% of the people own 95% of the wealth. The bulk of this 95% is in the hands of less than 2% of the people. The process of concentration of wealth and power is proceeding apace and is constantly enlarging the vast group of the economically insecure.

A steadily increasing mechanization of industry, which is increasing unemployment, without steps to adjust labor to the new conditions. To be

sound, society must provide labor for all who are fit to labor, and must care for all who are unfit. We are doing neither.

These deterring influences are serious. They constitute a constantly increasing menace. And yet, while they are frankly recognized by great numbers of intelligent Americans, we are doing very little to change them. Our newspapers carry abundant illustrations of every one of these charges. Our students, scholars, and economists fill the reviews and periodicals with warnings, but our statesmen seem unable and our business men seem unwilling to cope seriously with them.

Our International Problems

The United States has ample housecleaning of its own to do, in rectifying its internal affairs as set forth above. No inducements, other than our internal good, are needed to justify a most serious, determined, and intelligent effort to begin at once. But there is a most powerful spur from the outside, to do so, *viz.*, international competition.

We have here the highest wages and the highest average scale of living in the world. Because of this, in spite of our magnificent industrial organization and national efficiency, our product cost is high.

We are able to produce agricultural products, machinery, textiles, and manufactures of nearly all sorts, far in excess of what we can consume.

We must sell our surplus to other less developed nations, or we must cease to create the surplus.

We maintain our high wages and high scale of living by tariff walls, and invite thereby the imposition of retaliatory duties on our exports.

We cannot sell our surplus in competition with the products of countries where low-priced labor and low scale of living obtains, after they have become as well mechanized as we are now, or even partially as well.

To sell our surplus to Europe is becoming rapidly more difficult, as they profit by our example and mechanize their own industries. The markets of both Europe and the United States are narrowing down to tropical countries and the great areas of Asia where industrial development still lies dormant. We shall not be able to compete with Europe in these countries, if we adhere to our present policies and attitude of mind.

These comparisons are directed to those nations organized, as we are, upon the so-called capitalistic plan. The competition between Europe and the United States at least, is between peoples that believe in private property and free labor. But we are menaced now by a new danger, the Communist Russian government.

From Russia, we are threatened not only with all that has been set forth above, but with two new factors. First, collectivized labor, in which the element of wages virtually disappears, or is reduced to the actual cost of subsisting the laborers on a very low scale of living. Second, a

perfectly frank and plainly expressed intention to ruin us economically, as fast and as far as they can, in order to bring about distress and social and economic revolution, and thus to open the way to the ultimate triumph of their pernicious communistic scheme of social organization. I believe that Americans are in no danger of being successfully propagandized or converted to a social order, the very antithesis of everything that we love and revere, as long as we remain prosperous and well fed. But no nation is safe from revolution when its people live miserably and are in distress. The only hope that Communism can have here lies in wrecking our economic prosperity. And that their leaders clearly realize and have set themselves with cold reasoned malice to accomplish. None of our European competitors would have any compunctions about taking our foreign trade if they could, but it would be done without ill will to us as a people, or without desire to break down our ideals of civilized society, which they share with us. But Russia, under the Communist government, desires nothing so much as to break down our form of social organization. And, by skilfully mechanizing their industries and using our own methods, the threat they hold for our national integrity is greater and more malevolent by far than that of all Europe combined.

This outline of the forces which now threaten us is not merely imaginative. These forces are now in being and we are already beginning to feel their pressure. How shall we combat them?

I may venture a few suggestions in this line:

(1) Cut out the bunk from our politics. Make our politicians and statesmen face facts as they are or lose their places. The debates, political log rolling, and chicanery which characterizes the work of our Congress and State Legislatures is a disgrace. People recognize this but they have not yet made the politicians feel it by penalizing them at the ballot box, when they begin to use such methods. At least, the penalty is infrequent and long delayed.

(2) We must adjust the hours of labor to offset the increasing mechanization of industry. We must make it our serious purpose to distribute employment so that all who are able to work shall have the opportunity. Otherwise pauperization of the people must increase. We can keep out attacks on our present social system only if we arrange things so that everyone can find opportunity to earn a decent living. If we continue to permit such a distribution of the products of toil as creates a small class of immense wealth at the top, a middle-class shrinking in numbers and independence, and a large and growing working class whose jobs are insecure and whose actual living is frequently imperiled, and, among whom thrift is impossible, we must expect ultimate revolution.

(3) We must cut our tariffs as much and as often as is necessary to give American products a fair competitive chance with the products

of other countries. The world is bound in time to attain something like economic stability. Each nation in time will educate and train its population and mechanize its industry to a point where it will supply its own needs for everything that its natural resources permit it to produce. International trade will in time be limited to the exchange of things that the other cannot produce or can only produce under too great a handicap. The tropics must always trade with the temperate zones, because of the difference of their products. Agricultural countries without minerals will always trade with countries highly endowed with mineral wealth and those which are short of agricultural advantages. As this economic stability among the nations of the world is gradually attained, it must be our part to be able not only to support ourselves, but so far as possible obtain our share of that commerce between nations which will be permanent, because of the fact that it represents exchange of commodities which neither party can advantageously produce for itself.

(4) We must try by better education and training, by sounder economics and by social justice, to keep our place at the head of other nations as long as we can. We can only accomplish this by our efficiency, initiative, and skill, and we must abandon our silly arrogance and our false notions of security, and face world conditions as they are.

In this sketchy review of our national and international problems, I do not want to be considered an alarmist or a pessimist. I have tried to show that our factors of strength and security are at present the best in the world. If we handle them rightly and amend the faults of our form of government and our social and economic organization, we shall remain impregnable. But, if we sit in a fool's paradise, and refuse to give consideration to the changing forces of society, nothing is more certain than that we shall suffer bitterly for our sloth or our short-sighted self-sufficiency. In the affairs of a nation exactly as in the affairs of a corporation or an individual, constant vigilance, incessant self-criticism, and rigid self-discipline are necessary to prosperity.

My reason for interjecting this discussion upon this occasion is this: I believe that this SOCIETY, in common with all other bodies of intelligent American citizens, has a part to perform in keeping our nation strong and secure. We cannot leave it to others and expect it to be done. It is our business as well as theirs, and we should do our part, both as an organization and as individuals.

As a scientific, technical, and industrial body, our first and most obvious business is to tend to our own special affairs, for which no one else is responsible. If we make our industry a strong, well-organized one, filling our place in the general scheme of things, we shall have deserved well of our country.

But these other outside problems are a factor in accomplishing this pur-

pose. And therefore, while devoting our principal consideration to our special business, we should also give thought to these larger affairs which concern not only ourselves, but every American citizen. We should labor intelligently and self-sacrificingly to bring our industry to its proper place. And in just the same way and with an even more consecrated devotion, we should labor to bring our nation to a sense of its position in world society and world economics, and to help, rather than to hinder, in the solution of these problems which are already bringing unrest and insecurity to all of us. This is not only our duty; it is our privilege. What one of us would not respond instantly if he clearly saw an opportunity, by a personal sacrifice upon his part, to do a great service to his generation and to his posterity. That, Ladies and Gentlemen, is the privilege which American citizenship holds open to each and every one of you.

RECENT DEVELOPMENTS IN THE GERMAN CERAMIC INDUSTRY[1]

By Felix Singer

First of all permit me to express my sincere appreciation of the honor you have bestowed upon me by making me a Fellow of this Society. I value this all the more highly because it is a proof of the interchange of scientific ideas and the mutuality of interest with the scientists of other nations which prevails in this Society. And it is in this spirit that I am glad to avail myself of the privilege of addressing this gathering.

This is not my first appearance as a speaker before the American Ceramic Society. Three years ago when your meeting was held in Meissen in Germany, I had the honor of presenting to you a paper on "The German Ceramic Industry" written by my dear friend and colleague, Dr. Jungeblut, who, as you know, is the senior officer of my firm. It seems natural, therefore, that I go on this evening where I left off three years ago and try to outline to you in concentrated form the progress since made in the German ceramic industry. It is my purpose to point out particularly, problems concerning German practices and endeavors of the industry, which probably have not been fully covered by publication in the trade journals.

Touching upon a few of the main problems in the manufacture of ceramic products, the following summary may serve to give you an idea of recent German practice:

As to raw materials and their preparation, we are striving constantly to improve further the quality of raw materials and mixtures in the refining

[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February 25, 1931.

process, especially by way of removing iron content and by increasing the plasticity of kaolin and clay.

Particular attention is paid to the proper composition of different materials in the mixtures with the purpose of greatly increasing the quality of ceramic ware. Mechanical strength and other physical properties, more particularly the chemical resistance, have been considerably increased, with the result that we succeeded in expanding vastly the application of ceramic products in industry and for general use. And I believe that the German ceramic industry is fairly on its way of gaining for ceramic materials and products the wide and general recognition which their unique qualities merit.

As to shaping, the trend in Germany is practically the same as in this country, that is, we are as much concerned with replacing hand work by the use of machines as the American industry. Special machines are being used in increasing numbers, in spite of the fact that very often they are not to be found on the market but must be developed by ceramic engineers themselves for use in their own plants. Further progress has been made in the domain of casting ceramic mixtures by shortening the time of casting and by reducing the water content of the body.

In drying the ware, we follow the same path as our American colleagues. In order to shorten the drying time, drying chambers and drying tunnels are employed and economical use is made of the waste heat from kilns, from exhaust steam, and other available waste heat.

The most interesting progress that I can report to you has been made in the problem of firing.

Here the governing principle has been the elimination of waste which for a long time has kept firing costs high.

I have always had a great personal interest in all firing problems and I have made constant efforts to keep posted on modern achievements in this field. I believe, therefore, that I am correct when I say that, based on recent experiences and the conclusions drawn from them by the German industry, periodic kilns cannot be considered any more as suitable to economical mass production.

This does not mean to say that periodic kilns do not have other specific purposes to serve. It is my belief, however, that it is only a question of time until all plants making a large number of pieces, or firing a smaller number of pieces of the same size, will use continuous kilns exclusively. Continuous kilns fit perfectly into the modern idea of straight-line production. Research and extensive special studies have proved that all ceramic ware may be fired successfully in continuous kilns, provided, of course, that the type of kiln selected is designed to fit the purpose.

We have shown our great confidence in this new method of firing by building a tunnel kiln for the salt glazing of sewer pipe. For certain kinds

of ware the continuous gas-chamber kiln and the zigzag kiln have proved advantageous. The latter has shown excellent results in firing unglazed roofing tile. In a kiln of this type, 625 feet long, with a firing temperature of 1750°F excellent results could be achieved with the cheapest, inferior grade of coal available and in spite of this the fuel consumption amounted only to from 72 to 100 pounds of coal per ton of ware. This is the lowest coal consumption in firing which so far has come to our attention.

For a number of years, we have been particularly interested in Germany in the development of small, inexpensive types of tunnel kilns through which the ware moves either on small cars or on slabs or trays. They are generally known as "rapid fire kilns" and they have developed, without any detrimental effect on the quality of the ware, greatly increased speed in the preheating, soaking, and cooling time required. This is achieved by using a specially designed kiln showing a cross-section rather smaller than usual.

These kilns excel through their high degree of adaptability to variations in the volume of production. They are the logical firing equipment for concerns affected by seasonal and other business fluctuations, and they are being used profitably for the economical firing of small quantities.

Another interesting development in the use of small tunnel kilns should be reported, that is, the increasing demand for such small kilns for decorating purposes. Aside from the method of firing, progress has been made in the development of ceramic colors. The improved durability and intensity of ceramic coloring has greatly enhanced the marked ability of ceramic ware.

Finally, I would like to mention successful steps taken in the improvement of the grinding technique, which was necessitated by the increasingly exacting demands for precision on the part of our customers. Despite considerable difficulties, we have developed exact measurements to the point of $^1/_{25,000}$ of an inch.

I shall be glad indeed if these few remarks have given you a bird's eye view of recent accomplishments in the German ceramic industry. We believe that we have something to show for our serious and honest efforts, and that is why I would like to take this occasion to suggest that a more complete and much more interesting impression of what we are doing may be gained through personal inspection on the occasion of your next trip to Europe.

CHARLOTTENBURG
GERMANY

ACTIVITIES OF THE SOCIETY

CLEVELAND MEETING, 1931

The Thirty-Third Annual Meeting of the AMERICAN CERAMIC SOCIETY, held in Cleveland, Ohio, February 22–28, 1931, is now history. What was actually accomplished as far as the growth of the AMERICAN CERAMIC SOCIETY is concerned will be reviewed here briefly.

The American Ceramic Exposition held concurrently with the technical meetings made a separate and gratifying story of achieved success.

(1) The organization and dedication of the new Materials and Equipment Division has been discussed fully elsewhere.[1] The occasion of the formal induction of this Division on Monday evening at the Hollenden Hotel was conducted with dignity and simplicity. A brief prayer was offered by Henry Kleinfeldt and following the dinner talks were given by General Edward Orton, Jr., President E. V. Eskesen, H. P. Margerum, R. C. Purdy, and L. E. Riddle, the latter as Chairman of the Division. F. Gage Lord as temporary Secretary of the Division was also at the speakers' table.

(2) The reorganization of the Heavy Clay Products Division with the National Brick Manufacturers Association into the new Structural Clay Products Division was accomplished.[2]

(3) The organization and induction of members into the new grade of Fellows of the AMERICAN CERAMIC SOCIETY.[3]

(4) There was noticeable an intensified interest and keenness on the part of all the Divisions to build up the work of each particular Division and to emphasize restrictions which will be conducive to a closer union of Division interests. This was made evident especially in the selection of officers, men who were chosen for the constructive services they will be able to render to their Division during the coming year.

(5) The attendance at the Meeting established a record of more than 1700 persons. Even with the central location of Cleveland as a place of easy access by the majority of the members and the unparalleled spring days during the last week in February, the registration was unexpectedly large. As a result the Division meeting rooms were crowded at every session.

(6) The attitude of the Division officers and members in the weeks which have intervened since the Meeting has been one of unusual quickened interest. Committees are anxious to pursue plans suggested in February and authors have been prompt in forwarding papers. At the present time there are thirty papers more in the office than at this same date last year. This interest seems to indicate that the enthusiasm shown in Cleveland was not a spasmodic fervor, but a quiet, deep-rooted desire to carry on during the entire coming year.

It is to arouse this lasting interest that the AMERICAN CERAMIC SOCIETY has instituted and continued its Annual Meetings. If, however, this interest suffers an immediate collapse, the fundamental purpose of the Meeting has been defeated. The week of social and technical contact of these hundreds of members, in groups of their respective mutual interests, must supply a concentrated interest to endure for the next eleven months.

To supplement and revivify these contacts the SOCIETY publishes the technical papers and committee reports from month to month throughout the year. These publications also serve those members who have not found it possible to attend the Meeting.

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[1] See especially General Orton's presidential address, p. 73, this issue.

[2] Details of the organization of this Division will be found on p. 98, this issue.

[3] See page 89 for details.

The real test of the success of the Cleveland Meeting, therefore, will be the reaction of officers and members during the coming year, and until time for new enlivening in Washington, D. C., the week of February 7, 1932.

The work of the Cleveland Meeting is not over. The history of its success is not complete until the rest of the year 1931 tallies out its constructive, successful results.

The General Secretary and his staff of workers and the publications of the SOCIETY are at the service of the members to assist in stimulating this needed interest. It is hoped that the inspiration of large numbers attending and pleasant contacts made is a beginning of a year of pyramided success for each of the eight Industrial Divisions and of the SOCIETY as a unit.

INDUCTION OF FELLOWS AND OFFICERS, WEDNESDAY NIGHT, FEBRUARY 25, 1931[1]

Cleveland Public Auditorium

GENERAL ORTON: It is proper, I am sure, to spend a few brief moments to bring some realization to all of you as to just what this occasion means. Some may say that we are embarking upon a new plan or a new phase of our work. I prefer to view it a little differently. I think we are coming back to first principles.

When this SOCIETY started, it created two grades of membership. There was a grade which everybody could enter, and there was a grade which those people could enter who demonstrated their mettle; who had shown what was in them, not only as to their ability but their willingness to serve the SOCIETY, their willingness to give of themselves for the advancement of the cause. It does not cost very much to be a "jiner" but it costs a whole lot to be an effective worker.

We recognized that in the very beginning of this organization, and for years we operated along these lines. Then, some years ago, the qualifications for membership in the SOCIETY were changed, and it is now impossible to use the same phraseology and the same name that we used to employ when we wished to honor a man for his achievement. Then we called them Active Members. Now everybody is automatically an Active Member after two years of membership. But in order to create a grade of membership which shall imply those things I mentioned a moment ago and which I think will help us to restore the *esprit de corps* which characterized the early days of the SOCIETY, we have coined this expression, the Fellowship. It means that the members of the SOCIETY have confidence in the man who is nominated. It means that they have recognition of what he has done. It means that they have faith that he will do more.

The mode of organization of the Fellowship is probably known to all of you. The matter was not hastily embarked upon. Legislation was adopted a year ago. It was discussed and voted on and carried by a very large majority of those who voted, and it provided a definite constitutional program for putting this new grade of membership into effect.

The mode of selection of the Fellows was not laid down in rigid detail, but in order that it might be started, it was necessary to start somehow, somewhere. They placed upon the group of the charter members of the SOCIETY (all who are still alive and are members of the SOCIETY, numbering thirteen out of the original twenty-one) the duty of selecting a nucleus from which the new Fellowship would grow.

These older men, many of them retired from the more active work, probably not knowing a great percentage of members of the present day, were naturally unable to embark on a program of selecting one hundred men who represent the best brains, the best achievement, and the best service in the organization as it now stands. It would be a seriously difficult task for one not in contact with the present generation to attempt to do that.

[1] Notes from stenographic report of meeting.

What they did, and what I think was the right thing for them to have done, was to remember in this nucleus of one hundred members those who had in the old days won their spurs by the standards that were then set.

They took the old rosters and the new rosters, and they found out all who were in the SOCIETY now who had in the early days won this recognition. They found eighty-one of them. That means then that out of one hundred and fifty-three who are to receive recognition tonight, there are seventy-two representatives selected from the SOCIETY of this day and there are eighty-one of these older men who represent the earlier period and who are frankly being recognized here as a tribute to the part that they played in making today possible. Of course, some of them are still vigorous and active in the present day work of the SOCIETY, but many are not.

I believe that you will agree with me that this is a fitting thing to do, that we compliment ourselves in complimenting these men who have laid the foundatoins of this SOCIETY and borne the heat of battle during the first twenty years or so of its existence.

Now as to the seventy-two younger men who have been selected recently, it was necessary for the charter members to select up to the number of one hundred, because the provisions laid down in last year's legislation required that, and that was done on the only basis that was open to them to judge by.

Not knowing the personnel, a careful study was made of what the different men in the SOCIETY had done, and the list was filled from those who had impressive lists of contributions to show to their credit.

That brought us up to one hundred. The charter members had executed their task and were through, except as they fell into the one hundred themselves. The first one hundred Fellows elected then organized and proceeded to lay down the specifications or methods by which the Fellowship would grow and wax strong by addition of new Fellows.

The Constitution establishes all of the principal points, but in the Constitution it is necessary that there shall be some interpretations made and there shall be regulations for the carrying out of these provisions, and those have been laid down by the first one hundred Fellows.

You will all recognize that when the first meeting of the Fellows was called, on December 27,[1] it left very little time, less than sixty days, in which to print, prepare, and organize the necessary documents for putting this plan through, for securing the necessary jury to pass upon it, for arranging these various mechanical details, for getting the members of the SOCIETY aware of what was transpiring, and to get nominations made from the SOCIETY in order that they might be inducted at this time.

We only have some fifty-two who have been nominated in the regular manner which will be carried out hereafter, unless experience requires a change, and these men I would like to have you all understand, under the plans which have been set up, are nominated by their fellow members. They are selected from the body of the SOCIETY, from the Divisions in which they work, or from more than one Division, if necessary.

It is not supposed that a man sets in motion the plan of having himself promoted. That kind of thing is not done. It should not be done. The motion should come from his friends who recognize his merits and wish to do him honor.

Blanks are prepared on that basis. The nominee is not supposed to know that there is anything being done until he receives the blank carrying the signatures of his friends and co-workers who unite in asking his election. Naturally in order that we can pass upon his qualifications, the man who has been nominated must furnish certain information on his records, all of which must go to the jury.

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[1] For an account of this meeting, see *Bull. Amer. Ceram. Soc.*, **10** [2], 30–35 (1931).

This thing represents then a spontaneous movement on the part of the workers of the SOCIETY to put forward the men they want to see honored.

It should not in general emanate from the Fellows themselves. It is not desired to create a super-organization that stands at the top and reaches down and picks out its new men. If this movement is healthy, it must grow from the bottom up, the from the top down.

The workers in the Divisions know who are able and leading men, and should take the initiative in bringing them to the attention of the Fellowship.

Least of all should nominations originate from the officers of the SOCIETY. They know, of course, where the strength of the organization is. But as soon as the Fellowship becomes an official function, it becomes political and that would be fatal.

I hope this movement will proceed, as it has begun, from the ground up. Bring in your nominations, let them be considered on their merits.

I want to emphasize one other point before going on. After a group of you have nominated men and these papers are put in the hands of the Chairman and Fellows, they go to a jury for consideration. That jury is necessarily a secret body. Theirs is an arduous task. It takes a lot of time to give the necessary scrutiny to so many of these nominations and study what they contain and make inquiry and investigation into the records. It is a real job, and there are not so many who are willing to undertake one of that magnitude.

In the second place, if these men felt that in accepting this heavy job and the large amount of work that it entails, they were going to make personal enemies of many persons whom they know, by passing publicly upon the candidates, there simply would not be any jury. The safety of the proposition requires that the nominee shall not know the jury and the jury can pass, with absolute freedom and independence of thought and action, on the one point: Is this person big enough to receive this honor?

In the execution of this plan, having gotten that far, there remains one last step, namely the Board of Trustees.

In the old days the Board of Trustees had to consider every candidate who was being proposed for elevation to Active Membership. It used to take a large part of the time of their meetings. It took a large share of their energy. We were then a small SOCIETY, nowhere as big as any one of your present Divisions. The SOCIETY has grown too big for that. The financial responsibilities to be considered are too great. Our Board of Trustees cannot take on such a function as this and give proper consideration to it.

For that reason, the function of the Board of Trustees is to pass upon those men who are recommended by the Fellows. They can initiate no action in the matter themselves, nor do they pass upon those whose papers have been disapproved. They do have the last say in the matter of determining whether the Fellows' work is satisfactory in bringing forward any given person, thus putting the authority in the matter where it really should belong. The Board of Trustees is the supreme power of this organization.

Now as to the duties of the Fellows, I refer you to the Constitution for some definition of that. I will not attempt to go into it at all now.

I want to say that this must be regarded as a very small beginning of the task of creating a suitable and adequate Fellowship. There will be one hundred and fifty-three certificates granted tonight. Not all are here, of course. But this must be construed in the minds of all of us as a beginning and a beginning only. It does not mean that our timber is exhausted. It does not mean that the thing will not go on from year to year. And above all, it does not mean that the example or the moral effect of recognition for service performed will not bring in constantly young men working up into the SOCIETY. It will give them a goal on which to fasten their eyes, encourage them to climb the ladder

toward that goal. That is the real thing. The work of the Fellowship is to build an *esprit de corps* and incite the young, who are beginning, to put forth their best efforts to real achievement.

Perhaps some of you might say, "Well, it is a poor stick that has to be complimented with a piece of paper. If that is all there is to it, why should we work?"

Friends, human nature is the same the world over. Whether that is a good symptom or a bad symptom of human nature, you must determine. But there is no one who can deny the powerful stimulus which comes to all normal human beings when they receive the admiration and respect and the honor of their friends. None of us is immune. And, therefore, if we make use of this as a mode of inspiring the people of this SOCIETY to excel, we shall have helped them and we shall have helped the SOCIETY thereby.

I will not deliver any formal charge to the Fellows now. They will get tired of my charging anyhow, because I shall probably see them again later. I will only say one word to them: That there is in every effort of this sort, no matter whether it is in this organization or any other organization, always a little tendency to laugh at any ceremonious granting of an honor. There is that element in human nature, that makes people laugh or sneer at formality or dignified ritual. It comes from a lack of a really fundamental understanding of the purposes and value of formality and dignity.

I want you men and women to take this thing seriously. No one will laugh when they see that you are in deadly earnest in your efforts for this organization. No one is going to laugh at the Fellowship if they see the Fellows taking their duties seriously. Any little ripple which may be felt among us for a while will very soon be forgotten. But the good, solid work which you of the Fellowship will do and which you will inspire others to do will soon be fully appreciated by all.

President Orton then awarded the certificates to the following Fellows:

1. Duane Faxon Albery
2. Howard Clinton Arnold
3. Arthur J. Aubrey
4. Arthur Eugene Baggs
5. Cecil Eugene Bales
6. Lawrence Eugene Barringer
7. George Estes Barton
8. Phaon Hilborn Bates
9. Milton Ferdinand Beecher
10. Charles Fergus Binns
11. Marion Worthington Blair
12. Henry Hess Blau
13. Albert Victor Bleininger
14. George Addison Bole
15. Macdonald Charles Booze
16. George Herbert Brown
17. Wilbur Forman Brown
18. Stanley G. Burt
19. William Cannan, Jr.
20. Frederick Carder
21. Robert Linn Clare
22. Herman Louis Cook
23. Raymond Denny Cooke
24. R. Guy Cowan
25. Paul Ernest Cox
26. Edmund deForest Curtis
27. Thomas Stanley Curtis
28. Ralph Raymond Danielson
29. George Wesley Denison
30. Philip d'Huc Dressler
31. Dwight Thompson Farnham
32. Albra Henry Fessler
33. Alfred Nelson Finn
34. Francis Charles Flint
35. Marion Lawrence Fosdick
36. Chauncey Earl Frazier
37. Myrtle Meritt French
38. Robert Leonardson Frink
39. Edwin Henry Fritz
40. Clarence Edward Fulton
41. Sidney Longman Galpin
42. Treumund Walter Garve
43. William Day Gates
44. Samuel Geijsbeek
45. Roman F. Geller
46. Frederick Gelstharp
47. Robert Franklin Grady
48. Arthur Frederick Greaves-Walker
49. James Edward Hansen
50. William Nance Harrison
51. Carl Boileau Harrop
52. Frank Mather Hartford
53. Frederick Addison Harvey
54. Perry D. Helser
55. Herbert Barr Henderson
56. A. R. Heubach
57. Lowell Cleland Hewitt
58. Ercell Channing Hill
59. Major Edward Holmes
60. B. Mifflin Hood
61. Herford Hope
62. Roy Arthur Horning
63. John Clyde Hostetter
64. Adolph Fritz Hottinger

65. Walter Leonard Howat
66. Walter Austin Hull
67. Harold Phelps Humphrey
68. Ralph Kent Hursh
69. Charles Edwin Jackson
70. Joseph Arthur Jeffery
71. Robert W. Jones
72. Charles Henry Kerr
73. Charles Jackson Kirk
74. Frank Allen Kirkpatrick
75. A. Albert Klein
76. Theron Albert Klinefelter
77. Hobart McKinley Kraner
78. Junius Frederick Krehbiel
79. Robert Dallas Landrum
80. Karl Langenbeck
81. Walter Carl Lindemann
82. Jesse Talbot Littleton
83. George Allen Loomis
84. Ellis Lovejoy
85. Andrew Malinovszky
86. Mahlon Ellis Manson
87. William Keith McAfee
88. Taine Gilbert McDougal
89. John Spotts McDowell
90. Samuel John McDowell
91. John Milton McKinley
92. Leroy Himes Minton
93. Earle Towse Montgomery
94. Robert Joseph Montgomery
95. George D. Morris
96. Louis Navias
97. Ellsworth Price Ogden
98. Edward Orton, Jr.
99. Cullen Warner Parmelee
100. Albert Becker Peck
101. Forest Kizer Pence
102. Stuart Mortimore Phelps
103. Herman Arthur Plusch
104. Emerson Peck Poste
105. Amos Peaslee Potts
106. Ross Coffin Purdy
107. Barney Simonson Radcliffe
108. Frederick Hurten Rhead
109. Bryan Augustus Rice
110. Willard Durant Richardson
111. Frank Harwood Riddle
112. Heinrich Ries
113. James Thomas Robson
114. Donald William Ross
115. Samuel Ray Scholes
116. Edward Schramm
117. Harry George Schurecht
118. Joseph Bradfield Shaw
119. Mary Given Sheerer
120. Robert Ford Sherwood
121. Alexander Silverman
122. George Simcoe
123. Felix Singer
124. Robert Browning Sosman
125. Charles Douglas Spencer
126. Harry Spurrier
127. Homer Francis Staley
128. William Joseph Stephani
129. Halver Rufus Straight
130. Ray Thomas Stull
131. Eugene Cornelius Sullivan
132. Burton T. Sweely
133. K. Takahashi
134. William Chittenden Taylor
135. Paul Teetor
136. Edwin Ward Tillotson
137. Chester Charles Treischel
138. Louis Jacob Trostel
139. Karl Türk
140. Robert Twells
141. Charles Henry Walker
142. Francis William Walker
143. Francis William Walker, Jr.
144. Edwin Wight Washburn
145. Arthur Simeon Watts
146. Albert Ernest Roberts Westman
147. Herbert Allen Wheeler
148. William Garrison Whitford
149. Arthur Edwards Williams*
150. Hewitt Wilson
151. Harold George Wolfram
152. Wolsey Garnet Worcester
153. W. H. Zimmer

* Deceased.

Installation of Officers

We have now reached the last feature of the evening, namely the matter of the induction of officers. Will the officers who are to be inducted at this time kindly come forward? They are President Eskesen; Vice-President Silverman; Treasurer, Mr. Henderson; Members of the Board of Trustees, Mr. Poste, Mr. Sebring, and Mr. McKinley.

Gentlemen, you are about to be inducted as officers of the AMERICAN CERAMIC SOCIETY. Men become truly great only through the use of their faculties in behalf of their fellowmen. Great abilities devoted to selfish or personal ends may gain wealth, power, rank, adulation, but in the end these things turn to dust, leaving behind only a fleeting memory.

Organizations are like men. They are built of human units, and like these units they are bound by the same immutable laws. They become great by service, and by service only. Insofar as they reflect the high and noble ideals of their members, they grow in influence and prestige.

The AMERICAN CERAMIC SOCIETY was founded and has been carried on for these thirty-three years in the spirit of high purpose, to add to human knowledge, to promote acquaintance, to break down the barriers of a narrow, self-defeating secrecy, and to substitute in its place friendly coöperation, all for the greater good and glory of mankind.

You who are about to assume the direction of the affairs of this SOCIETY are greatly favored men, not because of the honor that has been conferred upon you, but because of the opportunity that is yours. You have a great responsibility to carry forward nobly

E. V. ESKESEN
(*President*)

A. SILVERMAN
(*Vice-President*)

EMERSON P. POSTE
(*Trustee, Enamel Division*)

C. L. SEBRING
(*Trustee, Art Division*)

J. M. MCKINLEY
(*Trustee, Refractories Division*)

the noble traditions of this SOCIETY. You are blessed above others in that your fellow members have selected you as the fitting representatives of this body to carry forward these traditions.

Will you kindly hold up your right hands and repeat after me this pledge, giving your name at the proper place and the office to which your are elected at the proper place:

I, ———, having been duly elected to the office of ———— of the AMERICAN CERAMIC SOCIETY, hereby in the presence of this assemblage, solemnly declare that I will, so far as in me lies, serve this SOCIETY faithfully and with a mind single to the great trust that has been reposed in me.

Gentlemen, you are elected and you are inducted into your respective offices.

PRESIDENT-ELECT ESKESEN: Ladies and Gentlemen: Before I take this exalted office held by General Orton so far, I would like to say a few words, and I would like to thank the Nominating Committee and the members for entrusting me with this great office in this great SOCIETY. I hope I will be good enough and strong enough and able to carry on the work which my predecessor has carried on.

When the office was first offered me, I did not feel that I could take it. I have been trying to eliminate myself as much as possible. I have been indeed in many things all over the country, and I thought I was getting toward that age where you could retire a little bit.

Then vanity got the best of me when this office was offered me, because when I came to conceive that I was going to take over the office from General Edward Orton, Jr., this great organizer and founder of your SOCIETY, and that I was going to wear his mantle, then I could not resist it. I am now here, and I hope I will be worthy. I try to have confidence in myself, and I will ask General Orton to have confidence in me that when I wear this mantle it will lose nothing of its luster.

It is a trying time at which I am taking over this office. The industry is hit by what we call hard times. We are passing through a period of distress that will affect all our members here, I think, and we are all wondering what is ahead of us. Let us hope that the work ahead of us will be crowned with success, that we may work our way through these times and toward something better, because we want this SOCIETY to grow.

Thirty-three years ago General Orton started this movement. At that time there was no AMERICAN CERAMIC SOCIETY. Just look at it and see how it has grown through all these years. We do not have to wonder where it will grow. We know that it will grow to something bigger and bigger all the time.

My admiration for General Orton and for the work done by all the men in this SOCIETY and for the SOCIETY itself is so great that I am yearning to do all I can to get the push back of me to do it. I will try to do it. But I want the confidence and support of you all, from General Orton down, and all the committees, and we will try to push along and get farther and farther toward success.

I thank you for the confidence shown in me.

OFFICERS OF THE AMERICAN CERAMIC SOCIETY

President:	E. V. Eskesen, Federal Seaboard Terra Cotta Corp., 10 E. 40th St., New York, N. Y.
Vice-President:	Alexander Silverman, Department of Chemistry, University of Pittsburgh, Pittsburgh, Pa.
Treasurer:	H. B. Henderson, 1445 Summit St., Columbus, Ohio
Secretary:	Ross C. Purdy, 2525 N. High St., Columbus, Ohio
Past-Presidents:	George A. Bole, Lord Hall, O. S. U., Columbus, Ohio
	Edward Orton, Jr., 1445 Summit St., Columbus, Ohio

Of the newly-elected officers, all of them are old friends, whose pictures have appeared before in the pages of the *Bulletin*. Mr. McKinley was re-elected as the Trustee for the Refractories Division. Mr. Sebring represents the Art Division and Mr. Poste, the Enamel Division on the Board of Trustees.

DIVISION COMMITTEE APPOINTMENTS FOR 1931-1932

Art Division	*Trustee:*	C. L. Sebring, Sebring Pottery, Sebring, Ohio
	Chairman:	Walter P. Suter, American Encaustic Tiling Co., 16 E. 41st St., New York, N. Y.
	Secretary:	Myrtle M. French, Art Institute, Chicago, Ill.

Enamel Division	*Trustee:*	E. P. Poste, Chattanooga Stamping & Enameling Co., Chattanooga, Tenn.
	Chairman:	Bryan A. Rice, The Pfaudler Co., Rochester, N. Y.
	Secretary:	W. N. Harrison, Bureau of Standards, Washington, D. C.
Glass Division	*Trustee:*	Charles D. Spencer, Glass Technical Dept., General Electric Co., 1133 E. 152nd St., Cleveland, Ohio
	Chairman:	G. W. Morey, Geophysical Laboratory, Washington, D. C.
	Secretary:	(To be appointed)
Materials and Equipment Division	*Trustee:*	(To be elected)
	Chairman:	L. E. Riddle, Jr., 112 Lake Ave., Metuchen, N. J.
	Secretary:	V. V. Kelsey, Room 1403, Trenton Trust Bldg., Trenton, N. J.
Refractories Division	*Trustee:*	J. M. McKinley, Box 37, Cleveland, Ohio
	Chairman:	A. E. R. Westman, Ontario Research Foundation, 47 Queen's Park, Toronto 5, Canada
	Secretary:	Dorothy A. Texter, 2218 Oliver Bldg., Pittsburgh, Pa.
Structural Clay Products Division	*Trustee:*	Henry C. Kleymeyer, Standard Brick Mfg. Co., Evansville, Ind.
	Chairman:	Howells Fréchette, Department of Mines, Mines Branch, Ottawa, Canada
	Secretary:	Amos P. Potts, 118 E. Blaine St., Brazil, Ind.
Terra Cotta Division	*Trustee:*	D. F. Albery, 2525 Clybourn Ave., Chicago, Ill.
	Chairman:	(To be elected)
	Secretary:	(To be elected)
White Wares Division	*Trustee:*	Edward Schramm, Onondaga Pottery Co., Syracuse, N. Y.
	Chairman:	E. H. Fritz, 710 Walnut St., Latrobe, Pa.
	Secretary:	H. M. Kraner, Westinghouse Electric & Mfg. Co., Derry, Pa.

MINUTES OF BOARD OF TRUSTEES MEETINGS, 1931

Sunday, February 22. Hotel Cleveland.

Present: Orton, Cox, Henderson, Booze, Bole, Curtis, Sweely, Spencer, and Kleymeyer. Mr. Eskesen, President-Elect, sat in.

(1) Secretary instructed to prepare and forward resolutions to Mrs. A. E. Williams.

(2) Approved list of twenty-six Fellows. None rejected.

(3) Moved by Schramm, seconded by Curtis that foreign on first 100 Fellow list be not billed for the $5.00 fee. Lost 2–6.

(4) Approved setting up separate ledger account of Fellow receipts and expenditures, the Fellows to recommend use of credit balance in the Fellow Fund.

(5) Instructed President Orton to appoint committee of five to attend Alfred University June Convocation and Ceramic Building cornerstone laying; this to be for honoring Dr. Charles F. Binns, retiring Director of New York School of Clayworking and Ceramics.

(6) Decision regarding 1931 summer meeting to be withheld until after Budget Committee report.

(7) Referred invitation of Pacific Section of American Association of Science to California Section, the Section to be instructed that the parent SOCIETY could not finance a summer meeting in California in 1931.

(8) Approved nominating an official delegate to Eleventh International Congress of Chemistry to be held in Madrid, Spain, in 1932. Dr. Alexander

Silverman was favored as delegate. Expenses can not be provided from SOCIETY's funds.

(9) President Orton appointed Wm. Cannan and Wolsey Worcester as Teller Committee.

Meeting, Wednesday, 2 P.M.

(1) Approved without exception all nominees for Fellows that were formally presented by the Chairman of Fellows.

(2) Approved plans for merging with N. B. M. A.
(See Thursday Minutes for resolutions approved, p. 98.)

(3) L. E. Barringer, Chairman of Rules Committee presented amendments which were largely in nature of codification to take care of (1) the new Materials and Equipment Division, (2) merger with A. R. I. and with N. B. M. A. Motion was on consideration of this amendment being presented in due form to be submitted to letter ballot. Carried.

(4) Passed following resolutions to be presented to the United States Commission for the Celebration of the Two Hundredth Anniversary of the birth of George Washington, 1932.

Whereas, The Congress of the United States has created a Commission to arrange a fitting nation-wide observance of the two hundredth anniversary of the birth of George Washington in 1932, and

Whereas, The Commission, so created, composed of the President of the United States, the Vice-President of the United States, the Speaker of the House of Representatives, four members of the United States Senate, four members of the House of Representatives, and eight citizens appointed by the President of the United States, is charged with the duty of planning and directing the celebration, and

Whereas, The high purpose of the event is to commemorate the life, character, and achievements of the most illustrious citizen of our Republic and to give to every man, woman, and child living under the Stars and Stripes an opportunity to take part in the celebration which will be outstanding in the world's history, and

Whereas, The George Washington Bicentennial Commission, desiring the full coöperation of the people in the United States has extended a most cordial and urgent invitation to our organization to participate in the celebration, therefore be it

Resolved, That the AMERICAN CERAMIC SOCIETY does hereby endorse the program of observance of the Two Hundredth Anniversary of the Birth of George Washington, to take place in 1932; accept with appreciation, the invitation of the George Washington Bicentennial Commission and pledge this organization to extend earnest coöperation to the United States Commission in all possible ways, so that future generations of American citizens may be inspired to live according to the example and precepts of Washington's exalted life and character, and thus perpetuate the American Republic, and be it further

Resolved, That the AMERICAN CERAMIC SOCIETY shall hold its Thirty-Fourth Annual Meeting in Washington, D. C., during the week of February 7, the same to be designated as the George Washington Bicentennial Anniversary meeting, and be it further

Resolved, That this resolution be incorporated in the official proceeding of this meeting and that a copy thereof be transmitted to the George Washington Bicentennial Commission, Washington, D. C.

Thursday, 2 P.M.[1]

Orton, Eskesen, Cox, Silverman, Henderson, McKinley, Schramm, Bole, Kleymeyer, Poste, Sweely, Spencer, present.

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[1] For continuation of business of this meeting see paragraphs (3) to (14), p. 103.

(1) Officers elect were considered as having right of voice and vote.

(2) Approved resolutions covering merger of N. B. M. A. with the SOCIETY. The resolutions and acts are as follows:

Acts and Resolutions Leading to Merger of N. B. M. A. with AMERICAN CERAMIC SOCIETY

(1) As a result of the conference held by President H. C. Kleymeyer of the National Brick Manufacturers Association, and Edward Orton, Jr., President of the AMERICAN CERAMIC SOCIETY, at Cleveland on February 22, 1931, the following Committees were appointed to confer as a joint Committee on a plan for consolidation of the two organizations named:

Representing the AMERICAN CERAMIC SOCIETY, Messrs. Amos P. Potts, M. W. Blair, and George W. Denison, all members of the Heavy Clay Products Division.

Representing the National Brick Manufacturers Association, Messrs. H. C. Kleymeyer, George B. Luckett, and John D. Martin.

(2) This Committee held a conference later on the same day and on Monday, February 23, adopted the following plan of consolidation:

Plan of Consolidation of the National Brick Manufacturers Association and the Heavy Clay Products Division of the AMERICAN CERAMIC SOCIETY

(1) *Whereas*, the two organizations above named are and have been for a considerable period of years working along parallel lines and have, to a large extent, the same field of interest, and have, to some considerable extent, been overlapping in their activities resulting in duplication of effort;

(2) *Whereas*, the membership of the two organizations is, to an appreciable extent, identical, and those persons who are members of both are bearing a double financial load, where one set of dues should be sufficient to procure the benefits naturally expected from each;

(3) *Whereas*, the interest and support of the clay manufacturing industries indicated would be stronger and more influential if it could be all brought to bear on one effective organization, and the interests of both groups would thereby be better served than is now the case where divided;

(4) *Therefore*, a basis of consolidation is herein recommended by the undersigned joint committee of the two groups, as follows:

Article 1: The present Heavy Clay Products Division of the AMERICAN CERAMIC SOCIETY shall pass out of existence and a new Division shall be formed, to be known as the Structural Clay Products Division of the AMERICAN CERAMIC SOCIETY.

Article 2: The field of interest of this section shall remain as present, comprising all brick, other than refractories; all structural hollow goods, such as sewer pipe, drain tile, conduits, hollow building block; all floor and roofing tile, and similar unclassified clay products which are primarily structural.

Article 3: The National Brick Manufacturers Association, as corporate entity, shall pass out of existence, and its members shall become members of the new Structural Clay Products Division.

Article 4: In order to preserve the name and to perpetuate and extend the primary interests of the National Brick Manufacturers Association in research, the solution of the problems of the clay manufacturer as encountered in this group of industries, to which it has made such important contributions in the past, there shall be constituted a corporation, not for profit, to be known as the

National Brick Manufacturers Research Foundation.

The function of this corporation shall be to receive all funds, pledges, and accounts receivable which may be in the treasury of the N. B. M. A. when that organization passes out of existence, and shall be the custodian of all new funds which may be secured hereafter, other than the ordinary dues which the members of the S. C. P. Division pay into the treasury of the A. C. S., and further to manage the Research Program of the S. C. P. Division and make all necessary disbursements therefor, through its properly constituted officer. The N. B. M. R. F. shall be an entirely separate entity from the

A. C. S. and its funds shall be entirely separate from the funds of the A. C. S. and under its own control.

Article 5: The management and control of the N. B. M. R. F. shall be vested in a Board of Directors, consisting of nine, all of whom shall be members of the S. C. P. Division of the A. C. S. and contributors to the N. B. M. R. F., and shall be elected under the rules and regulations of the S. C. P. Division as defined in the Constitution and By-Laws of that Division. Their terms of office shall be so arranged that they expire in rotation, three per year.

(Signed) H. C. KLEYMEYER, *Chairman*
AMOS P. POTTS
G. B. LUCKETT
M. W. BLAIR
GEO. W. DENISON
JOHN D. MARTIN

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(3) At the regular business meeting of the Heavy Clay Products Division called for the purpose of electing officers and transacting other business, which meeting was held in Hotel Cleveland, Monday evening, February 23, the following Resolution was adopted unanimously:

Resolution: That the Heavy Clay Products Division approves the plan of consolidation of the Heavy Clay Products Division of the AMERICAN CERAMIC SOCIETY and the National Brick Manufacturers Association as outlined, and that the officers had authority to so report to the Board of Trustees of the AMERICAN CERAMIC SOCIETY and request that the Board of Trustees take the necessary steps to bring about the proposed merger.

(4) At a meeting of the Board of Trustees of the AMERICAN CERAMIC SOCIETY held at the Hotel Cleveland, 2 P.M., Tuesday, February 24, the following Resolution was adopted:

Resolution: "WHEREAS the Board of the AMERICAN CERAMIC SOCIETY at a meeting February 26, 1931, passed the following resolution:

In accordance with Article I, a plan for consolidation of the National Brick Manufacturers Association and the Heavy Clay Products Division of the AMERICAN CERAMIC SOCIETY, which was adopted by the Board of Trustees of the AMERICAN CERAMIC SOCIETY at Cleveland, Ohio, on February 25, 1931, there is hereby created a new Division of the AMERICAN CERAMIC SOCIETY to be known as

The Structural Clay Products Division.

Authority is hereby granted to those members of the AMERICAN CERAMIC SOCIETY who may desire to work in the new Division to meet and organize, and elect temporary officers, who shall serve until a constitution and by-laws for the new Division shall have been prepared and adopted, and have been duly approved by the Committee on Rules of the AMERICAN CERAMIC SOCIETY, and by this Board of Trustees, after which the Division will be permanently organized under the Constitution and By-Laws thus adopted.

In accordance with Article I of the same plan above mentioned, the affairs of the present Heavy Clay Products Division shall be terminated and this Division shall pass out of existence when a resolution to this effect shall have been duly adopted by the members of the Division at a regular session of the Division, or failing this, by regular letter ballot. The resolution shall provide for the transfer of all records, accounts, assets, and liabilities from the Heavy Clay Products Division to the temporary officers of the Structural Clay Products Division when the latter has been constituted.

Therefore, Be It Resolved, the Heavy Clay Products Division of the AMERICAN CERAMIC SOCIETY is now terminated and "passes out of existence."

And Be It Further Resolved, that the Officers of the Division are instructed to transfer to the Temporary Officers of the new Structural Clay Products Division all records, accounts, assets, and liabilities of the said Heavy Clay Products Division as soon as the Structural Clay Products Division has been constituted.

(5) At a meeting of the Heavy Clay Products Division held on Thursday, February 26, a Resolution was adopted, providing according to the terms of a Resolution adopted by the Board of Trustees of the AMERICAN CERAMIC SOCIETY that on February 24, the Heavy Clay Products Division now formally disband and cease to function as a Division of the AMERICAN CERAMIC SOCIETY and its records and effects be now transferred to the new Structural Clay Products Division of the SOCIETY to be formed. This Resolution was adopted unanimously. The Division then adopted a motion to adjourn permanently.

Immediately thereafter those present which included a number of the members of the National Brick Manufacturers Association adopted the following Resolution:

Resolution: Whereas, by Resolution of February 22, 1931, previously read, the Board of Trustees of the AMERICAN CERAMIC SOCIETY has authorized the organization of a Structural Clay Products Division of the AMERICAN CERAMIC SOCIETY,

Therefore, Be It Resolved, that a new Division of the AMERICAN CERAMIC SOCIETY be now formed to be known as the Structural Clay Products Division. The object of this Division shall be the assembling, discussion, and promulgation of technical and engineering data, relating to the production and use of Structural Clay Products other than refractories, and

Be It Further Resolved, that all members of the former Heavy Clay Products Division and of the National Brick Manufacturers Association be now declared members of the Structural Clay Products Division.

Be It Further Resolved, that this group of members of the Structural Clay Products Division do now proceed to the election of Temporary Officers to complete the organization of said Division.

This Resolution having been adopted, the Structural Clay Products Division then proceeded to organize by the election of officers: Howells Fréchette, Chairman, John D. Martin, Vice-Chairman, Amos P. Potts, Secretary. A Committee was immediately appointed for the purpose of drawing up a By-Law for the government of the new Division and a meeting was set for Friday, February 27, P.M., at the auditorium in Cleveland to hear the report of the Committee on Rules and transact other business.

(6) At a meeting of the Structural Clay Products Division of the AMERICAN CERAMIC SOCIETY at 2 P.M., Friday, February 27, at the Cleveland Auditorium the following By-Laws for the Structural Clay Products Division were adopted.

By-Laws of the Structural Clay Products Division of the AMERICAN CERAMIC SOCIETY

Article I

Object

The object of this Division shall be to assemble, discuss, and promulgate technical and engineering data relating to the production and use of Structural Clay Products other than refractories.

Article II

Membership

Members of this Division must be members of the AMERICAN CERAMIC SOCIETY, who have declared that their major interests lie within the field of ceramics covered by this Division, and will have the same status in the Division as in the SOCIETY, as determined by the Constitution of the SOCIETY.

Article III

Dues

There shall be no dues in addition to the dues for membership in the AMERICAN CERAMIC SOCIETY.

Article IV

Section 1

The affairs of this Division shall be directed by a Chairman, Vice-Chairman, and Secretary, elected to serve one year, or until their successors have qualified. They shall take office at the last session of the Annual Meeting, at which they are elected.

Section 2

Chairman: The Chairman shall have supervision of the affairs of the Division and perform such other duties as usually pertain to this office.

Section 3

Vice-Chairman: The Vice-Chairman shall perform the duties of the Chairman in his absence or incapacity.

Section 4

Secretary: The Secretary shall keep proper minutes of all meetings of the Division, shall conduct and keep a full record of the correspondence of the Division, and shall perform such duties as may from time to time be assigned to his office by the Chairman of the Division. A vacancy in the office of Secretary shall be filled by appointment by the Chairman and Vice-Chairman.

Article V

Nominations and Elections

Section 1

The retiring Chairman at each Annual Meeting shall appoint a nominating committee of three members. The first two of them shall represent the Division on the nominating committee of the AMERICAN CERAMIC SOCIETY.

Section 2

The nominating committee shall submit to the Chairman by October 1, from the list of active members of the Division, the names of the nominees for Chairman, Vice-Chairman, Secretary, and when required, Trustee of the AMERICAN CERAMIC SOCIETY, accompanied by their acceptance of such nomination in writing.

Section 3

Additional nominations may be made as follows:

(*a*) By petition of ten members in writing, provided the petition is accompanied by the nominee's acceptance in writing and is received by the Secretary of the Division prior to December 15.
In this case the names will be entered upon the printed ballot in alphabetical order.

(*b*) By the voters writing in the names of members of the Division upon the blank spaces provided on the printed ballot, as in paragraph 6, section 5, of this article, at the time of voting. In this case the nominee's acceptance must be received by the Secretary of the Division prior to the close of the ballot.

Section 4

The report of the nominating committee of the Division shall be communicated to the membership through the November *Bulletin of the American Ceramic Society.*

Section 5

The election shall be by letter ballot conducted as follows:

(*a*) The Chairman of the Division upon receipt of the nominating committee's reports as provided in Sections 2 and 4 of this Article, shall certify to the General Secretary of the AMERICAN CERAMIC SOCIETY the names so submitted. The General Secretary shall then cause the names to be published as provided in Section 4 of this Article.

(*b*) Not later than thirty days before the Annual Meeting, the General Secretary shall mail to each voting member of the Division not in arrears, printed ballots containing alternately the names so submitted and blank spaces for use as in Section 3 of this Article.

(*c*) Said ballots shall be enclosed in an envelope on which there shall be no mark of identification other than the word "ballot." The ballot envelope shall be enclosed in another envelope for mailing, addressed to the Secretary of the Division, upon the back of which the voter shall endorse his name.
(*d*) The balloting shall close at twelve o'clock noon on the fifth day preceding the opening session of the convention, and the actual date shall be printed on the ballot.
(*e*) The envelopes and ballots shall be opened in the presence of three scrutineers, appointed by the Chairman, who will report the results of the election at the first session of the Division of the Annual Meeting.
(*f*) A plurality of affirmative votes cast shall elect.

Article VI

Standing Committees

Except as otherwise provided, the following Standing Committees (with duties as prescribed in the Constitution of the AMERICAN CERAMIC SOCIETY) shall be appointed annually by the Chairman of the Division.

Rules
Publications
Membership
Standards
Programs
Research
Data

Article VII

Meetings

Section 1

The annual meeting shall be at the time and place of the Annual Meeting of the AMERICAN CERAMIC SOCIETY.

Section 2

Special meetings of the Division may be called by the Chairman, or by petition of ten active members, upon thirty days notice.

Section 3

Twenty-five members shall constitute a quorum and the majority shall rule.

Section 4

Order of Business. The order of business at the Annual Meeting shall be as follows:

(1) Reading of minutes of previous meetings
(2) Secretary's Report
(3) Committee Reports
(4) Unfinished Business
(5) New Business
(6) Announcement of the Election of Officers
(7) Reading of Papers
(8) Installation of Officers and Appointment of Committees
(9) Adjournment

Article VIII

National Brick Manufacturers Research Foundation

Section 1

This shall be a corporation not for profit to be known as the National Brick Manufacturers Research Foundation for the following purposes:

(*a*) To take over and continue the previously conducted research work by the National Brick Manufacturers Association.
(*b*) To initiate and conduct research in the fields of production, properties, and uses of structural clay products.

Section 2

This Research Foundation shall be governed by a Board of Directors consisting of nine members. In the first Board of Directors the terms of office of three of these nine directors shall be for one year, of three others for two years and of the remaining three

for three years. The Board shall be perpetuated thereafter by the nomination and election of three members each year for terms of three years, according to the manner set out in the Articles of Incorporation, Constitution, and By-Laws of the National Brick Manufacturers Research Foundation.

Section 3

The directors shall report on the activities of the Foundation of the Structural Clay Products Division and submit detailed reports for transmittal to the SOCIETY for publication under the rules of the SOCIETY without any cost to the Foundation.

Article IX

Amendments

Amendments to these By-Laws must be proposed by ten members at an annual meeting, and if endorsed by a two-thirds vote of the members present, must be submitted to the Board of Trustees of the AMERICAN CERAMIC SOCIETY for final approval.

At this same session the following Resolution was adopted by the Structural Clay Products Division:

Resolution: "Whereas, the joint report of the Committees of the AMERICAN CERAMIC SOCIETY and the National Brick Manufacturers Association duly approved by both organizations, authorizes the creation of the National Brick Manufacturers Research Foundation to take over and extend the research work which has been carried on by the National Brick Manufacturers Association, and to initiate such other research as may be deemed by the Board of Directors of such Foundation desirable in the fields of the production and use of structural clay products.

Therefore, Be It Resolved, that such Foundation be now organized and that the following be designated as the temporary Board of Directors to effect such organization.

JOHN D. MARTIN
C. FORREST TEFFT
AMOS P. POTTS
DOUGLAS F. STEVENS
G. B. LUCKETT
J. OTIS WILCOX
HENRY C. KLEYMEYER
EDWARD E. KRAUSS
EBEN RODGERS

Thursday 2 P.M. Continuation of meeting (see p. 97).

(3) Granted honorary membership to Dr. Otto Schott and to Dr. J. W. Mellor.
(4) Honorary membership for Dr. A. L. Day was referred to Fellows for recommendation.
(5) Budget Committee reported as follows.

We, the Budget Committee, beg to report as follows a total budget of $40,950, distributed as follows:

Rental	$1080	Extra Expense	
Salaries	13,920	Traveling	$500
Printing	18,000	Secretary's Office	2000
Abstracts	1800	Annual Meeting	1000
Editor's Office	1000	Committee	100
Soliciting Advertising	250	Division Expense	200
Reprints		President's Office	100
Postage	1000	Miscellaneous	
		Total	$40,950

And further recommend that this distribution of funds be maintained or reduced if possible. The Budget Committee feels that the SOCIETY should retrench our expenditures so as to bring them within our income. And further suggest that no increases be made in salaries. We feel, however, that many of the activities which it will be necessary to curtail in order to follow out the above policy are well worth while and in

the event that conditions should change and our income be increased we would recommend that they should be resumed.

H. C. KLEYMEYER
B. T. SWEELY
H. B. HENDERSON
C. D. SPENCER

This budget report was withdrawn by the mover.

(6) Moved by McKinley, seconded by Silverman that the following be adopted. This motion carried.

It is moved that the budget for the current year be set at a total of $40,000 to be pro-rated to the various SOCIETY accounts in line with recommendation of Budget Committee report, the Secretary to have authority to increase or decrease the various items, provided he does not alter the total.

It is further moved that the President appoint a committee of three with the President, Secretary, and Treasurer, added *ex-officio*, to employ a certified Public Accountant to direct the installation of an adequate cost and accounting system through which complete and clearly defined balance sheet and profit and loss statements can be issued from the Secretary's and Treasurer's offices each month, and at the end of each year, the expense of this audit to be added to the Budget.

(7) Moved by Schramm, seconded by Henderson, that a small Committee be appointed to establish Annual Meeting registration fee of $2.00 for members attending 1932 Annual Meeting. (Admission to technical sessions by badge only.) Carried.

(8) Moved by Henderson, seconded by Silverman, that a registration of $4.00 for nonmembers and $2.00 for authenticated students be established for the 1932 Meeting. (Admission to technical sessions by badge only.) Carried.

(9) Moved by Silverman, seconded by Poste, that an Endowment Fund Committee of three be empowered to enlist coöperation of others in the securing of supporting funds from Endowment Corporations. Carried.

(10) Moved by Silverman that a Publicity Agent be employed for the 1932 Meeting. Amended that this be referred to an Executive Committee. Carried as amended.

(11) Moved by Schramm, seconded by Henderson, that the Board elect by letter ballot a committee of three members of the Board to confer with the Secretary at least quarterly on administrative matters with power to act for the Board. Carried.

(12) Report of Committee of Awards was referred to the Fellows.

(13) Ross C. Purdy was elected to serve as Secretary for the year 1931–1932.

REPORT OF THE COMMITTEE ON EDUCATION

We take pleasure in submitting herewith the report of the Committee on Education of the AMERICAN CERAMIC SOCIETY for the year 1930–31.

The report of the Committee for the year 1929–30 contained the following seven resolutions:

I. *Resolved:* That the Committee on Education of the AMERICAN CERAMIC SOCIETY does hereby recommend to the various departments of ceramic education in the United States and Canada that every curriculum in ceramic engineering or ceramic technology should contain, as a minimum, 40% of the total credit hours in the fundamental sciences.

II. *Resolved:* That the Committee on Education of the AMERICAN CERAMIC SOCIETY does hereby recommend to the various departments of ceramic education in the United States and Canada that every curriculum in ceramic engineering or ceramic

technology should contain, as a minimum, 15% of the total credit hours in cultural subjects.

III. *Resolved:* That the Committee on Education of the AMERICAN CERAMIC SOCIETY does hereby recommend to the various departments of ceramic education in the United States and Canada that every curriculum in ceramic engineering or ceramic technology should contain, as a minimum, 8% of the total credit hours in subjects dealing with business and management.

IV. *Resolved:* That the Committee on Education of the AMERICAN CERAMIC SOCIETY does hereby recommend to the various departments of ceramic education in the United States and Canada that instruction in ceramic technology in four-year curricula be, when possible, confined to the technology of clay products (including special bodies and special refractories), or, the technology of enameled ware or the technology of glass.

V. *Resolved:* That the Committee on Education of the AMERICAN CERAMIC SOCIETY does hereby recommend to the various departments of ceramic education in the United States and Canada that schools wishing to offer instruction in one curriculum in more than one of these main divisions of ceramic technology extend the length of the curriculum to at least five years.

VI. *Resolved:* That the Committee on Education of the AMERICAN CERAMIC SOCIETY does hereby recommend to the various departments of ceramic education in the United States and Canada that no course in enameling technology be offered unless courses in foundry practice and metallurgy of iron and steel are given as prerequisites or concomitants.

VII. *Resolved:* That the foregoing six resolutions are to be considered as tentative recommendations and are to be submitted to the ceramic schools for discussion and revision during the next twelve months and will be brought up for final action at the next Annual Meeting of the SOCIETY.

In accord with Resolution VII, copies of these resolutions have been submitted during the past year to the various ceramic schools for discussion and comments. Replies have been received from (1) Ohio State University, (2) Massachusetts Institute of Technology, (3) Pennsylvania State College, (4) University of Toronto, (5) Iowa State College, (6) Georgia School of Technology, (7) Virginia Polytechnic Institute, (8) North Carolina State College of Agriculture and Engineering, (9) Missouri School of Mines and Metallurgy of the University of Missouri, and (10) New York State School of Clayworking and Ceramics. While this list is not a complete list of the ceramic schools of the country, it certainly is a representative list and the judgment of the heads of these Departments of Ceramic Engineering may be taken as indicative of the opinion of the ceramic schools of the country in general.

Resolutions I and VI were approved by 100% of those making comments. Resolution II was approved by 90% of those making comments, and the tenth commenter stated that in his school they recommend students in need of cultural training to elect practically the amount of cultural subjects suggested by the Committee. In connection with this resolution it should be pointed out that in certain provinces of Canada, particularly Ontario, a five-year high school course is required and therefore in this case the fifth year of high school can be considered the equivalent of part of the cultural work suggested in this resolution.

Resolution III was approved by 50% of the commenters and the remaining commenters suggested that while they approved of some requirements for subjects dealing with business and management, they thought 8% was too high for a minimum. The Committee sees some weight in this argument and therefore is willing to reduce the recommendation for minimum requirements in subjects dealing with business and management to 4% of the total credit hours in the course.

In regard to the two remaining resolutions, IV and V, there was no unanimity of opinion. The majority of the heads of the various Ceramic Departments believe that a five-year course in ceramic engineering is not practicable at the present time, although it would be desirable from a pedagogical standpoint. With regard to the subject matter of the courses in the Departments of Ceramic Engineering in the present four-

year courses, each commenter insists that it is necessary to teach the fundamentals of ceramic engineering, but there is a wide divergence of opinion among the various commenters as to what constitutes the fundamentals of ceramic engineering.

Your present Committee on Education recommends that Resolutions I, II, and VI be adopted as final as written. It recommends that in Resolution III the figure of 8% be altered to 4% and that the resolution as so altered be adopted as final. It recommends that Resolutions IV and V be referred back to the Committee on Education for further investigation and study.

During the past year a request from the International Correspondence Schools for information as to the desirability of establishing correspondence schools in ceramic subjects was referred to this Committee. The Committee has conducted a rather voluminous correspondence in regard to this subject but has not been able to come to a decision; first, as to whether the establishment of such courses is possible and, second, as to whether they would be for the ultimate good of the ceramic industries. The Committee will welcome suggestions from any one interested.

In January of this year, J. B. Shaw, Head of the Department of Ceramics, The Pennsylvania State College, and a member of this Committee, presented a paper entitled, "Training Ceramic Engineers,"[1] before the Pittsburgh Section of the SOCIETY. This paper contains a comprehensive discussion of the educational situation in the field of ceramics and a very interesting proposal in regard to a new kind of required summer work for students in ceramic engineering. It is suggested by the Committee that this paper be published along with this report.

Respectfully submitted,

Committee on Education,
AMERICAN CERAMIC SOCIETY

HOMER F. STALEY, *Chairman*
ARTHUR E. BAGGS
A. LEE BENNETT
M. E. HOLMES
FRANK H. RIDDLE
J. B. SHAW
E. WARD TILLOTSON

TRAINING CERAMIC ENGINEERS[2]

BY J. B. SHAW

Dr. Ralph B. Hetzel, President of the Pennsylvania State College recently advised that a committee of the faculty make a thorough review of the curricula and academic activities of the institution as a whole with a view to recommending such changes as might be effective in adopting those methods and principles of higher education which have in recent years proved their worth and eliminating those which have become obsolete or unappropriate.

The Committee on Education of the AMERICAN CERAMIC SOCIETY has had the subject of Ceramic Education under consideration for several years. Careful study has been made of the work given at each of the colleges. The results obtained, as exemplified in the achievements of ceramic graduates in the field of ceramics, have been noted. The recognized requirements of ceramic industries for scientifically-trained men have

[1] See the following paper.

[2] Brief of paper read at Meeting of Pittsburgh Section, AMERICAN CERAMIC SOCIETY, January 13, 1931.

guided and stimulated the study. As a result of the study a series of recommendations has been made by the Committee. These recommendations in the form of resolutions were published last year.[1]

Analysis of the Pennsylvania State College curriculum shows the proportion of the student's time devoted to various phases of education to be

Fundamental sciences	41.5%
Cultural subjects	13.0
Silicate technology (ceramics)	23.2
Allied engineering subjects	14.3
Business management (economics)	2.0
Physical development	6.0

It will be noted that the first two items are substantially in accord with the recommendation of the Committee on Education; these being a minimum of 40% for fundamental sciences and 15% for cultural subjects. Analysis of the curricula of all of the schools shows that, while varying in some cases, most of them recognize the soundness of these recommendations and 50% or more of the student's time is devoted to these basic studies.

Further analysis of the curricula to determine how the remainder of the time of the student is used shows that the curriculum at Pennsylvania State College would require material readjustment to bring it into accord with the ideas of the Committee on Education. The curricula of the different schools vary widely in regard to this portion of the work and all of them will require modification to comply with the recommendations of the Committee.

It has been previously pointed out that some of the schools have already responded to suggestions which were made two years ago by subdividing the work required into separate options: Ceramic Technology and Ceramic Engineering. Response to the recommendations of the Committee would now require a further revision resulting in more detailed specialization of the work in ceramics.

Reverting to the first paragraph quoted from the catalogue of the Missouri School of Mines, one notes.

"It is the object of the department of Ceramic Engineering to train students, as completely as possible, for a career in the ceramic industries."

This brief paragraph is unquestionably applicable to every department of Ceramic Engineering.

Recognizing the fact that all departments have the same functions to perform; realizing that the different departments are at variance with one another in the character of the work given and that the Committee on Education of the AMERICAN CERAMIC SOCIETY advises modifications involving radical changes in the program of all departments, what is to be done about it?

The situation places each of those in charge of ceramic instruction under obligation to review their own program in the light of their environment and circumstances, taking counsel with those more directly interested in their particular departments, and if adjustments in curricula are advisable, to act accordingly.

The revision of an existing curriculum in ceramics or the laying down of a new one requires study of many factors. Desiderata of primary importance to guide one are (1) the interests of the student himself, (2) the environments of the department, not only in reference to the industries which the department must serve and which are to be its direct support, but also with regard to the facilities of other departments of instruction associated with the department under revision, and (3) the character of training best

[1] See *Bull. Amer. Ceram. Soc.*, 9 [4],120 (1930).

calculated to fit students for a career in ceramic industries as a whole, irrespective of immediate environment.

When one considers the interests of the student, the question is immediately raised as to whether the desirable course of training consists of a more or less narrow specialization or a broader general training in Silicate Technology and Engineering. No definite and specific answer can be given to this question. The answer depends upon the student. In some cases, one course will be best; in other cases, another course. If one considers the fact that something like 60% of the graduates from engineering schools do not follow the profession for which they are trained in college, one is bound to reflect seriously upon the justice of limiting the training of his students to a particular branch of one of the engineering professions. On the other hand, it is recognized in this age of specialization that the man specially trained for a particular field is likely to get farthest in that profession.

A matter of interest in the ceramic field is the close relationship in the technology of all branches. While there are a half-dozen different ceramic industries which loom large in the industrial world, still the basic principles of Engineering and Science in their operation are very similar. All are based upon Silicate Science and Technology. A thorough knowledge of the governing principles in any one of them requires a considerable understanding of all of them and, what is still more important, a complete general knowledge of all of them will assuredly enhance one's ability to master thoroughly any one of them.

The value of specialization in academic training has been thoroughly demonstrated in the development of American industry and science but there is undoubtedly a point beyond which such training loses much of its value both to industry and the individual concerned.

Those in control of industry cannot be justly criticized for demanding men more thoroughly trained in each of their respective branches, but those responsible for the academic training of ceramic technologists, having in view the ultimate best interests of the student as well as the ceramic industries, will find difficulty in justifying a course which limits the student's training to a single phase of the silicate industry, thereby depriving him of a broad training which will enable him in limited time to develop into a successful man in any field of his choice. The student thus narrowly trained is at a grave disadvantage in case he wishes to change his activities to another branch of ceramics or perhaps to some field of engineering or science other than ceramics. Not only this, but indeed it is probable that the same student would get farther in the field of his early choice and be ultimately of more value to any single branch if given the benefit of broader training covering fundamentals of all fields of ceramics at the expense of more detailed training in a particular one.

A four-year course in academic training should develop the average student so as to make him eligible for the B.S. degree. A student in ceramic engineering to be eligible for the degree should have the following training and qualifications named in what is considered to be the order of importance.

(1) The ability to concentrate, to think clearly in a straight line, to reason from cause to effect and *vice versa* (*i.e.*, skilful use of the brain as distinguished from skilful use of the hands by the mechanic); good character; and confidence in his ability with a minimum of ego.

(2) The ability to use the English language in conveying ideas, including the ability to spell, speak, and write fluently and clearly.

(3) Chemistry and physics and physical chemistry including the ability to translate pure chemistry and physics into the language of ceramic technology.

(4) Mathematics, including calculus and mechanics.

(5) Silicate technology and engineering, including a thorough knowledge of the properties of all silicates both natural and artificial; a general understanding of processes

and equipment involved in all ceramic industries and the basic differences between processes and products of each branch of the industry.

(6) Mineralogy including the ability to use the petrographic microscope effectively.

(7) Allied engineering subjects, electrical engineering, mechanical engineering, metallurgy, mining engineering, civil engineering, including an understanding of those phases of these branches of engineering involving the use of ceramic products and reasonable ability to apply these phases of engineering in ceramic production.

(8) Geology, fundamental and economic.

The ability of students to acquire the training and qualifications here outlined depends upon (1) the capacity and diligence of the student, (2) the ability of instructors to inspire and direct the activities of the student, and (3) a properly balanced curriculum to guide the efforts of both student and instructor, supplemented by adequate equipment in the way of library and laboratory facilities and coöperation of the industries.

There is one change in the curriculum at the Pennsylvania State College which it is believed would greatly enhance the value of the course in ceramics to the industries of the State and result in marked improvement in the training of the students. This change represents a radical departure from anything heretofore attempted in ceramic instruction and would involve a measure of confidence and coöperation on the part of the industries which it is perhaps unreasonable to expect. Because of its radical nature the scheme has not been heretofore proposed though it has long been the hope of the writer that it might be brought to realization. It is brought forward at this time in the hope that those in charge of the ceramic industries will give it earnest consideration and, if perchance it should not appear altogether unreasonable, a plan of action on it may be developed.

The curriculum at Pennsylvania State College contains a course in Ceramics 14 (ceramic plant study) and Ceramics 16 (local inspection trips).[1] These two courses designate work involving inspection trips to manufacturing plants over the State and writing of reports describing the students' observations. These inspection trips require about two weeks' time, in the course of which from 15 to 20 plants are visited. The work has always been recognized as one of the most valuable and effective portions of the curriculum in inspiring the student and enabling him to visualize the field of ceramics and silicate technology in the light of his fundamental training in the sciences. The scheme in mind is to increase the value of this training, perhaps many fold.

Some departments of ceramics require a period of some weeks or months of bona fide employment in a ceramic plant before graduation. The value of such work is fully recognized. Some of the older ceramic engineers attribute a large portion of their later success to the experience they gained while wheeling brick or shoveling clay. There are few graduates who would not profit by such experience. The scheme it is proposed to outline has for its object the multiplication of benefits to be derived from such experience.

It will be admitted by all that the greatest value obtained from such practical experience does not come from the physical exertion involved in wheeling brick nor from the envelope received with the laboring man's wages. The value results largely from the fact that the graduate gets close contact with the laborer, seeing his problems from his point of view. He absorbs the atmosphere of the factory from the standpoint of the factory worker himself and is thereby better able in the future to appreciate the problems of the laborer.

[1] The writer has never asked a ceramic manufacturer in this State for assistance or coöperation in any form that it was not forthcoming with hearty good-will. The industries of the State are and always have been willing and anxious to coöperate and assist the Department in every possible manner. The appreciation of those in charge of the department for this fine interest is here expressed.

The inspection of a glass plant by passing from one department to another, observing each operation as it is explained by a guide, is intensely interesting to one who has never seen it and one absorbs much information by such a visit, but the things which crowd themselves upon him one after another are often times so jumbled together that the observer finds himself bewildered.

It is suggested that a scheme of coöperation between the Department of Ceramics and the industries be outlined which will enable the student to make a detailed study of the ceramic industries.

It is proposed that instead of send ng the student into the plant to wheel brick for three months or leading him through a score of plants in a period of days, he be sent into a few carefully selected plants with a notebook and be required to spend a period of say two weeks, nine hours per day, in each plant in a careful detailed study of every phase of operation, including materials, equipment, processes, and personnel. Under this scheme each student would be required to spend the summer following the junior year in such a study of a half dozen or more plants followed by a satisfactory written report.

It is believed that work of this character would be of far more value in developing ceramic engineers than anything heretofore undertaken in the way of coördinating the operations in the industries with the work at school. The plants selected for the study would be diversified so as to cover, as nearly as possible, every field of ceramic production.

The operation of this scheme from the standpoint of the department would be extremely simple. It would entail some hardships for some students in that they would be required to spend the summer at work without pay (it is difficult to see how one could justify asking the operator to pay wages to students doing such work, except on the basis of pure philanthropy). This difficulty, however, is not insurmountable. The only remaining question is as to the attitude of those in charge of the industries toward such procedure. As heretofore noticed, the operation of the scheme involves the willingness of manufacturers to throw their plants open to detailed study by one student after another. Trade secrets, if there be such in ceramic industries, would be subjected to possible revelation. The students would be expected and required to make as little nuisance of themselves as possible, but it would be inevitable that some little interruption to operations might result. The accomplishment of the thing sought for would require that the student converse with the workmen as well as foremen and superintendents. It would be desirable to have only one student in a plant at a time. This would be easily realized until the student body becomes much larger than at present. Only a limited number of plants could be studied; eight or ten would be sufficient. If a greater number were available, the program would involve less trouble at each plant under study.

Recognizing that the operation of the plan involves considerable concession on the part of the manufacturers, there are also undoubted advantages for them in it. The student and manufacturers would become acquainted at a comparatively early period in the student's college work. Managers and owners would have opportunity to observe each student in the department at work.

Reports of students could be made available to all manufacturers if desired or, if preferred, reports on each plant would be submitted only to the owners. It is obvious such a plan would provide an excellent opportunity for each manufacturer to select for employment such students as impress him favorably.

On the other hand, this opportunity to study a plant in each branch of the ceramic industry would give the student a reasonable amount of solid information on which to decide which phase of the industry appeals to him most.

The plan is outlined with the hope that those in control of the ceramic industries in Pennsylvania will give it serious consideration. In the event that it proves acceptable

to a sufficient number of manufacturers, the Department of Ceramics at the Pennsylvania State College will be glad to carry out its provisions with the least possible inconvenience to the industry.

CERAMIC DEPARTMENT
PENNSYLVANIA STATE COLLEGE
STATE COLLEGE, PA.

REPORT OF THE COMMITTEE ON PUBLICATIONS FOR 1930

This report of the Publication Committee for 1930 includes (1) a list of the publications in preparation for the year 1931, in addition to the regular monthly issues, (2) a survey of the work of the editorial office for the past five years, with emphasis on 1930 publications, and (3) an analysis of the expenditures for the publications for this period.

I. 1931 Publications in Addition to Current Issues of the Journal

This subject is discussed first because of the importance of finding some method to finance the publications which follow:

(1) "A Compilation of Phase-Rule Diagrams of Interest to the Ceramist and Silicate Technologist," by F. P. Hall. This manuscript as received includes 33 pages of copy and more than 136 cuts, the drawings for which are nearing completion. The retracing of these figures and expenditure on the cuts cannot be carried in the regular Journal printing budget.

(2) Manuscript on a book of Ceramic Calculations by James T. Robson has been received. The work has been reviewed by the Publication Committee and is recommended for immediate publication. Financing of this work must be taken care of outside of the monthly publication budget. The manuscript covers 344 pages of copy.

(3) A translation from the German of a valuable report on "Glass Melting Furnaces" has been made. Publication of this material, which includes 109 pages of manuscript and 79 cuts is being urged, but a guaranty for its financing before it is sent to the printer is necessary.

(4) Bibliography of Bibliographies. This valuable compilation is now in type and will be given publication in the early spring. The expense involved, however, will run considerably higher than the monthly publication allowance.

(5) Ceramic Book List. This Book List in its present form includes 13 galleys of 8-point solid type. The galley proof has been sent to every Ceramic School and to many libraries throughout the country for criticism and additional titles. It is estimated that the list will cover nearly one hundred pages when complete. It will serve as a competent guide on any subject relating to ceramics. A list of requests for the Book List is on file in the editorial office and many letters have been received urging the completion of the work. As in the case of the preceding work, lack of funds for assistance in revision and for printing are holding up its publication.

(6) In Preparation. Two other publications are now in preparation: (1) Bibliography on White Ware and (2) Reference Glossary of Ceramic Terms.

II. The Journal

In the past five years a total of 486 original papers, covering every phase of ceramics, has been published in the *Journal*. (See Table II.) In addition to these papers, 203 pages of the Standards Report were published in the June, 1929, issue. In 1930, the Art Division Symposium, including 8 original papers and 5 committee reports, was published as Part II of the May issue.

The charts show the page increase during the past few years, but they cannot adequately indicate the value of the papers as they come to the members of the SOCIETY each month, a value which will automatically increase as the years go on.

Division Editors for the Journal Several of the Divisions have communicated with the Publication Committee regarding the appointment of an Editorial Committee that will supervise the papers published in the *Journal*, relating to their particular interests in ceramics. A Committee on Publications for the Refrac-

tories Division has been organized and has worked successfully with the editorial office during the year 1930.

The Publication Committee and the Editor of the *Journal* will welcome such coöperation from the Divisions, but in making such appointments, care must be exercised to appoint men who will have the time and patience to work through the material promptly, in order not to delay the scheduled publication of the work.

III. Ceramic Abstracts

During the past four years a total of 4138 pages of abstracts and their separate author and subject indexes has been issued. This includes a total of 20,000 abstracts and patents of literature from every ceramic journal published.

It would be impossible for any person to attempt to compile a bibliography on any subject relating to ceramics without first making a complete check from this collection of abstracts and patents.

From Table III it is easy to see the total number of abstracts published under the various classifications. Glass has more than 3000 abstracts and patents; refractories, more than 2000; art, almost 1500; white ware, more than 1000; heavy clay products, almost 1200; enamel, almost 800; terra cotta is low, with a total of 251 in four years.

In addition to the above seven classifications which correspond to the seven industrial Divisions, there are seven other groups which are of general interest to persons of all Divisions.

(1) Abstractors and Journal Abstracts The assistant editors of *Ceramic Abstracts*, in addition to checking, preparing for the printer, proof reading, and indexing each months' abstracts (all copy is read twice before going to the printer, 2 times in galley proof, and once in page proof), have a corps of 28 abstractors scattered throughout the United States and in Japan, Czechoslovakia, and Australia. Two hundred and fifty journals are assigned to these abstractors and their work must be carefully checked each month to be certain that all assignments are kept up-to-date.

Every ceramic journal that publishes abstracts is checked so that journals which are not on the list of assignments may not be overlooked.

(2) Abstracts for 1931 Although the number of abstracts published and the total pages for the first three months of 1931 exceed the totals for the same period in 1930, the final total for 1931 will probably not be much higher than for last year. This does not mean that the abstracts of ceramic literature reached a saturation point in 1930 and cannot be increased, but a closer editing is being observed on abstracts from those journals which can be readily obtained by our members. Foreign journals and journals published in this country which are difficult to secure will be given as much space as possible.

(3) Division Editors for Ceramic Abstracts As with the *Journal*, several Divisions have asked for information concerning the appointment of Abstract Editors to check the work relating to the abstracts of their particular Division. Abstract editors would be of great help to the work of editing the abstracts, an assistance which would be welcomed by the editorial office. The work, however, would involve a strict adherence to schedule by each Editor. If his work should lapse for only one issue, the schedule of abstracts would confront a serious handicap.

Divisions wishing to adopt this service should consult with the Publication Committee concerning arrangements for editors and also for the financing of this service.

IV. The Bulletin

The editor needs time and assistance financially for the promotion of ceramic research and education through the pages of the *Bulletin*.

The Editorial and Papers and Discussions Sections should have more space. In the

Activities of the Society Section, more attention should be given to Local Section Meetings, Division Reports, Student Group Meetings, letters valuable to the work of the SOCIETY, all of which would mean increased contact with members, and a means of getting the members of the SOCIETY acquainted with individuals and the work they are pursuing in ceramics.

V. Author and Subject Indexes

In Table IV it is shown that there is an increase of more than 5000 index references in 1930 over 1929. All author indexes have always been made by the members of the editorial staff. In 1930, there was an expenditure of nearly $500 for outside help on the subject indexes of our publications.

The work of compiling the subject indexes for the *Journal*, *Abstracts*, and *Bulletin* for 1931 will be done in the editorial office under the supervision of the Editor. The work will have to be done almost entirely outside of regular office time.

VI. Editorial Expense for 1930

The item shown in Table I of $1837 charged to editor's office expense includes such items as retracing drawings for cuts for the *Journal*, $500 for the 1930 index, subscriptions to journals used in abstracting and temporary assistance in the office. While an effort will be made to reduce this total considerably in 1931, such restriction cannot help but handicap the progress of the work.

VII. Office Assistance in Editorial Work

The editorial work discussed in this report is carried on by the Editor and three full-time assistants. Very little outside help is available for this work for two reasons: (1) financial (as always) and (2) because of the technical character of the work, a person must be trained in the work over a period of several months to render any more than the most routine assistance. As a result, when outside publications such as bibliographies, book lists, etc., come to the editorial office for preparation for the printer, the work is taken on as an outside activity of the four members of the editorial staff.

If finances permitted, a part-time editorial assistant should be in process of training at the present time so as to be ready for the peak-load of publishing, especially during the months preceding the preparation of the indexes and the Annual Meeting period, when papers are preprinted in advance, equivalent to four or five months' work.

TABLE I

Journal Expense	1926	1927	1928	1929	1930
Cost of Publication	$13,596.63	$16,144.37	$18,181.80	$20,311.71	$22,939.05
Editor's Office Expense	1,912.83	1,378.41	1,734.45	1,218.38	1,837.30
Abstracts	677.21	1,135.47	1,812.05	2,133.42	2,569.69
Reprints (Gross)	1,846.74	1,656.29	1,089.99	1,075.84	1,525.92
Total Expense	$18,033.41	$20,314.54	$22,818.29	$24,739.35	$28,871.96
Salaries	11,643.28	13,794.03	13,909.11	13,769.30	14,759.75
Net Advertising Income	14,007.15	15,062.96	14,511.17	14,146.95	15,077.16
Total Personal Memberships Dec. 31	2181	2196	2262	2371	2554
Total Corporation Memberships Dec. 31	326	320	315	314	300
Total Receipts for Personal Dues	$15,082.21	A.R.I. $15,976.87	$16,179.90	$16,912.40	$954.50 $16,153.19
Total Receipts for Corporation Dues	6,847.00	6,847.50	6,515.55	6,422.71	5,951.35
Total Income	$21,929.21	$22,819.37	$22,695.45	$23,335.11	$23,059.04

TABLE II

TOTAL PAGES IN JOURNAL, ABSTRACTS, AND BULLETIN, 1926–1930

Publication	1926	1927	1928[1]	1929[2]	1930[3]	Total
Journal (total pages)	896	1028	934	830	976	4,664
Total number of original papers	(93)	(102)	(95)	(96)	(104)	(486)
Ceramic Abstracts	494	718	1024	1124	1296	4,656
Bulletin	494	388	396	380	354	2,012
Totals	1884	2134	2354	2334	2626	11,332

[1] The entire *Journal* section in June, 1928, was given over to a Standards Report of 203 pages.

[2] The Enamel Bibliography was issued as Part II, May, 1929. This Bibliography contains 385 pages of 8-point type with complete Author and Subject Indexes.

[3] This does not include the Art Division Symposium, published as Part II of the May, 1930, issue. There were 8 original papers and 5 committee reports, a total of 68 pages.

TABLE III

TOTAL NUMBER OF ABSTRACTS PUBLISHED ACCORDING TO SUBJECT CLASSIFICATION (1927–1930)

	1927	1928	1929	1930
Abrasive	45	205	444	463
Art	222	295	495	477
Cement, etc.	349	309	269	462
Enamel	96	154	229	286
Glass	714	775	718	985
H. C. P.	208	264	281	430
Refractories	402	433	589	659
Terra Cotta	32	58	76	85
White Ware	177	258	300	270
Equipment, etc.	186	334	276	628
Kilns, etc.	243	447	365	680
Geology	133	167	231	328
Chemistry, etc.	422	486	505	560
General	330	362	506	767
Total Abstracts	3559	4547	5285	7080
Total No. of Pages	718	1024	1100	1296

TABLE IV

INDEX REFERENCES (AUTHOR AND SUBJECT) 1929–1930

	1929	1930
Journal (author)	121	143
" (subject)	1,447	2,711
Abstract (author)	4,262	5,432
" (subject)	13,105	13,599
Bulletin (author and subject)	518	488
Art Division Symposium		147
List of Ceramic Publications		787
	19,453	23,207

LOCAL SECTION NEWS

Pacific Northwest Section[1]

A joint meeting of the Pacific Northwest Section of the AMERICAN CERAMIC SOCIETY and the North Pacific Section of the American Institute of Mining Engineers was held February 17, at Seattle, Wash. This included a dinner at the University of Washington Commons and the following program at Guggenheim Hall:

[1] Hewitt Wilson, *Secretary*.

"Liquid Gas," by Charles R. Collins, Consulting Engineer.

"Manufactured Gas," by J. S. Holt, General Superintendent, Seattle Gas Co.

These two talks were followed by the five-reel motion picture, "The Manufacture of Refractories," of the Harbison-Walker Refractories Co. A. G. Suydam, Pacific Coast Sales Manager, answered questions and explained a number of interesting phases of the work.

About 45 persons were present at this meeting.

NEW MEMBERS RECEIVED IN FEBRUARY

CORPORATION

Swindell-Dressler Corp., Ralph W. Porter (voter), P. O. Box 1753, Pittsburgh, Pa.

United Clay Mines Corp., Kenneth M. Smith (voter), Oakland and Prospect Sts., Trenton, N. J.

PERSONAL

Raphael F. Alcan, Superintendent, American Encaustic Tiling Co., Maurer, N. J.

J. Carlton Atherton, 2084 Neil Ave., Columbus, Ohio; Assistant Professor, Ceramic Art, Ohio State University.

R. S. Barlow, 23 LaSalle Ave., Trenton, N. J.; Roessler & Hasslacher Chemical Co.

E. J. Bernhard, Assistant Manager, Ceramic Dept., Roessler & Hasslacher Chemical Co., 10 E. 40th St., New York, N. Y.

Arthur John Campbell, Oulton, Stone, Staffs, England; Director, Mintons, Ltd.

Robert M. Curts, Engineer, Technical Division, American Potash & Chemical Corp., 233 Broadway, New York, N. Y.

Probert W. Dager, Champion Porcelain Co., Butler Ave. and Grand Trunk R. R., Detroit, Mich.

Redfield T. Dinwiddie, Manager, Refractories Division, M. W. Kellogg Co., 225 Broadway, New York, N. Y.

R. H. Dufault, Manager, Ceramic Dept., Roessler & Hasslacher Chemical Co., 10 E. 40th St., New York, N. Y.

Raymond W. Dwyer, Manager, Syracuse Pottery, Inc., Syracuse, N. Y.

Theodore Norbert Hubbuch, Engineer, American Potash and Chemical Corp., 233 Broadway, New York, N. Y.

G. W. Jarman, Jr., President, Separations Engineering Corp., 31 Nassau St., New York, N. Y.

George H. King, District Manager, General Refractories Co., 1210 Genesee Bldg., Buffalo, N. Y.

Albert W. Laubengayer, Assistant Professor, Department of Chemistry, Cornell University, Ithaca, N. Y.

Edgar Littlefield, 307 15th Ave., Columbus, Ohio; Assistant Instructor, Ceramic Art Dept., Ohio State University.

Eva C. Moore, 121 Summerhill Ave., Toronto, Ontario, Canada.

Walter Travis Priestley, 3 Pinder View, Lower Wortley, Leeds, Yorkshire, England; Assistant Works Chemist, Farnley Iron Co., Ltd.

John Ries, 512 Columbus Ave., Trenton, N. J.; Superintendent of Plant 5, Trenton Potteries Co., Trenton, N. J.

E. W. Rugh, 431 Winter Ave., New Castle, Pa.; Ceramic Engineer, New Castle Refractories Co.

H. M. Scott, 102 Buckingham Ave., Trenton, N. J.; W. H. Hughes & Co.

Guilio Ellsworth Sievert, 435 Highland, San Mateo, Calif.; Ceramic Engineer, West Coast Porcelain Mfrs.

Robert Wakefield Watkin, 416 College St., Alliance, Ohio; Ceramic Instructor, Sebring High School.

STUDENT

W. Stewart Kuttler, University of Illinois, Urbana, Ill.
Charles L. Lester, North Carolina State College, Raleigh, N. C.
Robert W. Slaughter, University of Illinois, Urbana, Ill.
Howard G. Wilcox, University of Washington, Seattle, Wash.

Membership Workers' Record

CORPORATION	
R. W. Rowland	1
Office	1
Total	2

STUDENT	
A. F. Greaves-Walker	1
C. L. Thompson	2
Hewitt Wilson	1
Total	4

PERSONAL	
Arthur E. Baggs	2
C. M. Dennis	2
C. F. Geiger	1
James Hamilton	1
W. B. Kerr	1
A. Malinovszky	1
Bernard Moor	1
G. D. Morris	1
F. H. Riddle	1
H. Ries	1
V. J. Roehm	1
Walter Sheard	1
Geo. Simcoe	1
Office	7
Total	22
Grand Total	28

ROSTER CHANGES IN FEBRUARY

PERSONAL*

Aubrey, Arthur J., Sterling Brick Co., Olean, N. Y. (462 Crandall Ave., Youngstown, Ohio.)
Bates, Charles E., Spotswood, N. J. (Old Bridge, N. J.)
Bennett, Dwight G., Mellon Institute, Pittsburgh, Pa. (Metal & Thermit Corp., Carteret, N. J.)
Blake, A. E., 1511 Dickinson Rd., West Brookline, Pa. (Detroit, Mich.)
Clark, Paul M., Georgia Kaolin Co., Dry Branch, Ga. (261 High St., Macon, Ga.)
Feichter, Harold R., P. O. Box 140, Magnolia, Ohio. (P. O. Box 66, E. Sparta, Ohio.)
Frank, Henry A., 4100 South Alameda St., Los Angeles, Calif.; Eljer Calif. Co. (616 W. 56th St., Los Angeles, Calif.)
Hagar, Donald, 1135 Brighton Blvd., Zanesville, Ohio. (Box 836, Cincinnati, Ohio.)
Hartman, M. L., Room 660, Subway Terminal Bldg., 417 South Hill St., Los Angeles, Calif. (253 S. Maple Drive, Beverly Hills, Calif.)
Hofstetter, Gerald W., Westinghouse Electric and Mfg. Co., Mansfield, Ohio. (1560 N. 4th St., Columbus, Ohio.)
Hutt, Gordon M., Department of Development, Canadian Pacific Railway, Room 40, C. P. R. Office Bldg., Winnipeg, Manitoba, Canada. (Montreal, Quebec.)
Kingloff, J. I., O. Hommel Co., Pittsburgh, Pa. (Chattanooga Stamping & Enameling Co., Chattanooga, Tenn.)

* Addresses within parentheses ( ) represent the old addresses.
The roster changes which are published each month may be checked against the complete Membership Roster which appeared in the July, 1929, issue of the *Bulletin*. Copies of this issue may be obtained from the Secretary's office, price $2.00.

Kirk, H. S., 305 Highland Ave., New Castle, Pa. (47 Berwyn St., Orange, N. J.)
Lawson, Geo. G., 1709 Livingston St., Evanston, Ill. (1218 Forest Ave., Wilmette, Ill.)
McBerty, R. K., 150 W. Frambes Ave., Columbus, Ohio. (Dallas Ave., Tarentum, Pa.)
Mansur, Howard H., Lincoln, Calif. (Taylor, Wash.)
Roessler, H. F., 1140 Martine Ave., Plainfield, N. J. (Perth Amboy, N. J.)
Salisbury, Frank W., N. E. Cor. 16th St. and Sherman Drive, Indianapolis, Ind. (Durant City, Pa.)
Seabright, Edward C., 249–7th St., Martins Ferry, Ohio. (Y. M. C. A., Hamilton, Ohio.)
Shaw, Myril C., Ohio State University Engineering Experiment Station, Roseville, Ohio. (5728 Darlington Rd., Pittsburgh, Pa.)
Simison, Allen L., Glass & Furnace Division, Owens-Illinois Glass Co., Toledo, Ohio. (Berney-Bond Glass Co., Columbus, Ohio.)
Smith, Dorothy James, 17 W. 12th, New York, N. Y. (Edgewood School, Greenwich, Conn.)
Whitmer, J. D., Cambridge Tile Co., P. O. Box 836, Cincinnati, Ohio. (Flint Faience Tile Co., Flint, Mich.)
Wong, Edwin, China General Edison Co., Inc., 140 Robison Rd., Shanghai, China. (2127 Central Ave., Cleveland, Ohio.)

NOTES AND NEWS

CERAMIC SCHOOL NOTES

University of Toronto[1]

A ceramic scholarship has been announced which will amount to $50 per year for 10 years and will be awarded to the ceramic student obtaining the highest scholastic standing in the third year. The first award will be in 1932. This scholarship is donated by the Canadian National Clay Products Association which was influential in having the Ceramic Department started at the University five years ago.

This Association also made arrangements to pay the railway fare of any of the ceramic students attending the Annual Meeting of the AMERICAN CERAMIC SOCIETY in Cleveland. The value of the meeting is recognized and the Association feels that the young men going into the local plants should have the opportunity to attend.

CALENDAR OF MEETINGS

Organization	Date	Place
American Assn. for the Advancement of Science	December 28, 1931 to January 2, 1932	New Orleans, La.
AMERICAN CERAMIC SOCIETY	February 7–13, 1932	Washington, D. C.
American Chemical Society	March 30 to April 3	Indianapolis, Ind.
American Concrete Institute	February 22, 1932	Washington, D. C.
American Electrochemical Society	April 23–25	Birmingham, Ala.
American Foundrymen's Assn.	May 4–7	Chicago, Ill.
American Gas Assn.	October 12–18	Atlantic City, N. J.
American Glassware Mfrs.	July	Atlantic City, N. J.
American Institute of Chemical Engineers	June	Swampscott, Mass.
American Iron and Steel Institute	May 22	New York, N. Y.

[1] R. J. Montgomery.

American Society of Mechanical Engineers	April 20–23	Birmingham, Ala.
American Society for Testing Materials	June 22–26	Chicago, Ill.
National Assn. of Mfrs. of Heating and Cooking Appliances	May	New York, N. Y.
National Exposition of Power and Mechanical Engineering	December 5–10	New York, N. Y.
National Glass Distributors Assn.	December 1–3	Pittsburgh, Pa.
National Safety Council	October 12–16	Chicago, Ill.
New Jersey Clay Workers Assn.	June	Asbury Park, N. J.
Scientific Apparatus Makers of America	May	Newport, R. I.
Taylor Society, Inc.	May 1 and 2	Philadelphia, Pa.
Tile & Mantel Contractors' Assn.	April 14–17	Milwaukee, Wis.

What the Carborundum Company Recuperators are Doing in a Noted Glassware Plant . . .

TO reverse the usual order and begin with a summary, these recuperators are saving $4680.00 per year on three glassware units.

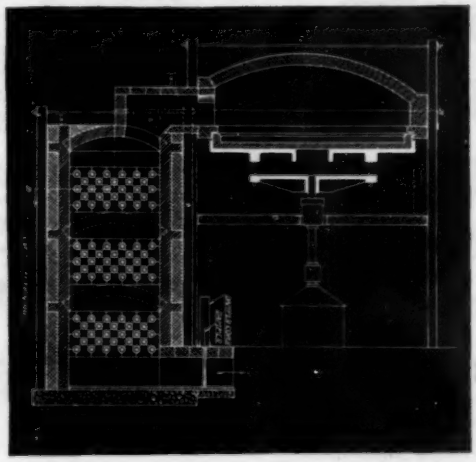
But that isn't all of the story—

In detail the three recuperators are used in conjunction with three 10-foot pots, each producing 65,000 lbs. of glass daily.

We guaranteed to reduce gas consumption from 51,000 cu. ft. when operating with clay recuperators to 48,000 cu. ft. of 1,150 B.T.U. gas daily.

The guarantee was fulfilled with a comfortable margin as fuel consumption on carefully supervised tests dropped to 43,300 cu. ft.

Operating, labor and upkeep costs were cut—and quicker starting—smoother operation—easier control and far less trouble from leakage were the other results from this Carborundum Company recuperator installation.



Each of the three recuperators utilizes banks of tubes made from "Carbofrax"—the "Carborundum" Brand Silicon Carbide Refractory. The tubes are 52 inches long, ⅛ inch thick walls.

The high thermal conductivity of "Carbofrax" and its remarkable refractoriness are responsible for years of operation with no recuperator maintenance charges and the reduction of flue gas temperatures from 1775° F. entering the recuperator to 650° F. at the stack.

The estimated life of the installation is 10 years.

CARBOFRAX

REG. U. S. PAT. OFF.

THE CARBORUNDUM BRAND SILICON CARBIDE REFRACTORY

Carborundum Engineers will gladly give you more information

THE CARBORUNDUM COMPANY

REG. U. S. PAT. OFF.

PERTH AMBOY, N. J.

(CARBORUNDUM AND CARBOFRAX ARE REGISTERED TRADE MARKS OF THE CARBORUNDUM COMPANY)

BUYERS' GUIDE

A

Aloxite (Refractory Products)
Carborundum Co.

Alumina (Hydrate and Calcined)
Harshaw Chemical Co.
Hommel, O., Co.
Pennsylvania Salt Mfg. Co.

Aluminum Oxide (Fused)
The Exolon Co.
Harshaw Chemical Co.

Alundum (Refractory Products)
Norton Co.

Ammonium Bifluoride
Harshaw Chemical Co.
Hommel, O., Co.

Ammonium Carbonate
Harshaw Chemical Co.
Hommel, O., Co.

Antimony Oxide
Harshaw Chemical Co.
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B

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McDanel Refractory Porcelain Co.

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Barium Carbonate
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Hommel, O., Co.

Barytes
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Hommel, O., Co.

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Norton Co. ("Alundum-Crystolon")

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Norton Co.

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Norton Co.

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Hommel, O., Co.
Harshaw Chemical Co.
Pacific Coast Borax Co.

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Harshaw Chemical Co.
Pacific Coast Borax Co.

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Pacific Coast Borax Co.

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Harshaw Chemical Co.
Hommel, O., Co.
Pacific Coast Borax Co.

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Harbison-Walker Refractories Co.
Norton Co. (*"Alundum-Crystolon"*)

C

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Carborundum Co.

Carbolon (Refractory Products)
The Exolon Co.

Carbon Dioxide Meters
Brown Instrument Co.

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Hommel, O., Co.

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Harshaw Chemical Co.
Hommel, O., Co.
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Potters Supply Co.
Spinks Clay Co., H. C.

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Harshaw Chemical Co.
Hommel, O., Co

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Harshaw Chemical Co.
Kentucky-Tennessee Clay Co.
Spinks Clay Co., H. C.

Clay (Enamel)
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Harshaw Chemical Co.
Hommel, O., Co.
Kentucky-Tennessee Clay Co.
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Vitro Mfg. Co.

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Clay (Sagger)
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Harshaw Chemical Co.
Kentucky-Tennessee Clay Co.
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Hommel, O., Co.

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Drying Machinery
Philadelphia Drying Machinery Co.

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Harbison-Walker Refractories Co.
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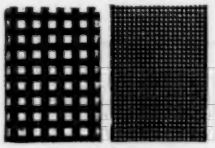

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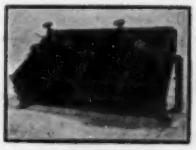

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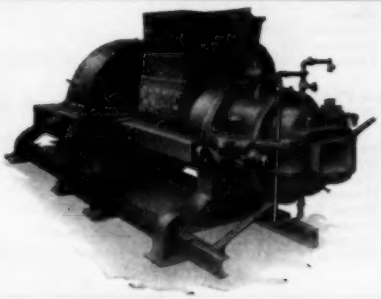

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O

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P

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Norton Co.
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Hommel, O., Co.
Vitro Mfg. Co.

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Harshaw Chemical Co.
Hommel, O., Co.

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Sieves (Testing)
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Philadelphia Quartz Co.

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The Exolon Co.

Silicon Carbide Firesand
The Exolon Co.

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Norton Co.

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Norton Co.

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Porcelain Enamel & Mfg. Co.

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Hommel, O., Co.

Sodium Antimonate
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Hommel, O., Co.
Metal & Thermit Corp.
Vitro Mfg. Co.

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Hommel, O., Co.

Spar
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Hommel, O., Co.
Pennsylvania Pulverizing Co.

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Stilts
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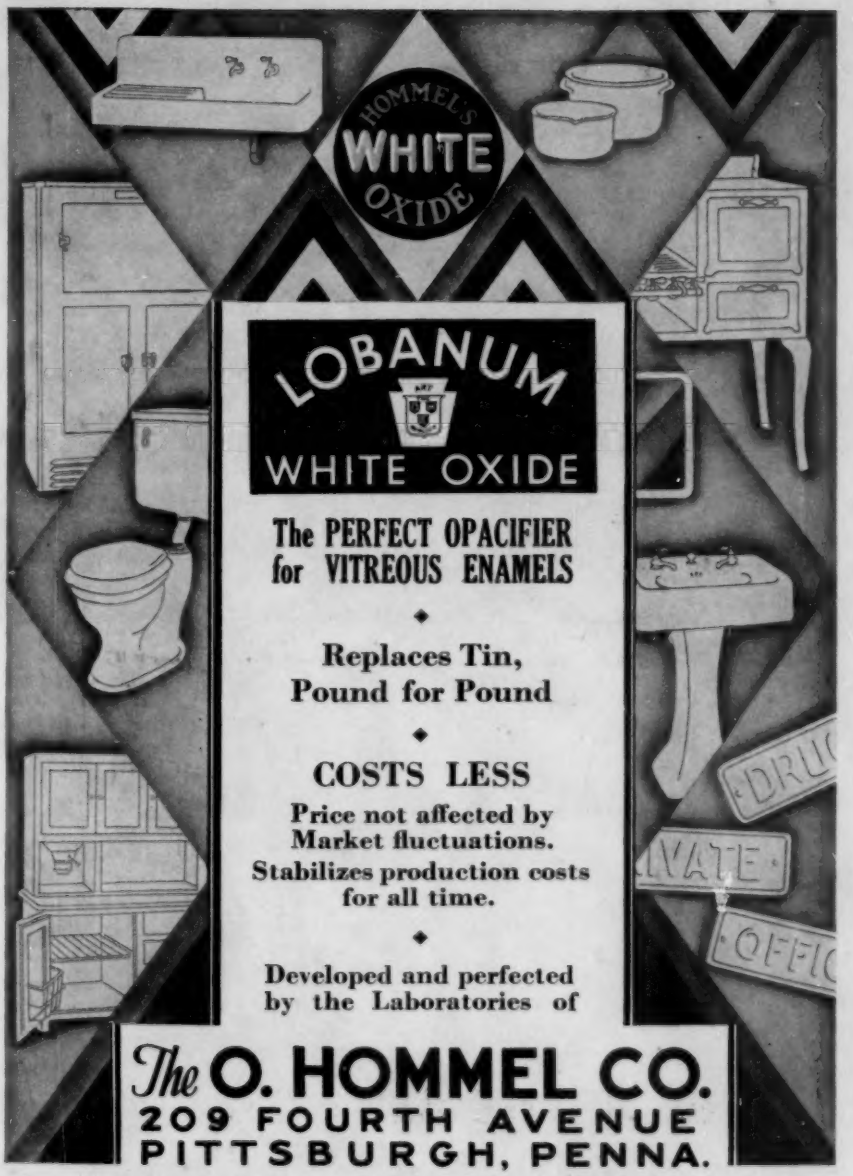

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